Solar® 8000M
Patient Monitor
Operator's Manual

Software Version 3

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GE Medical Systems
Information Technologies

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CE Marking Information

CE

Compliance

The Solar 8000M bears CE mark CE-0459 indicating its conformity with the provisions of the Council Directive 93/42/EEC concerning medical devices and fulfills the essential requirements of Annex I of this directive. The product is in radio-interference protection class A in accordance with EN 55011.

The country of manufacture can be found on the equipment labeling.

The product complies with the requirements of standard EN 60601-1-2 “Electromagnetic Compatibility - Medical Electrical Equipment”.

Exceptions

The Solar 8000M system EMC: Immunity Performance — IEC 60601-1-2 Medical Electrical Equipment, Part 1: General Requirements for Safety, 2. Collateral Standard: Electromagnetic compatibility—Requirements and tests. Section 36.202.a—Radiated electromagnetic fields states: For Patient Coupled Equipment and/or systems applicable IMMUNITY levels are under consideration. The 3 volts per meter IMMUNITY level may be inappropriate because the physiological signals measured can be substantially below those induced by a field strength of 3 volts per meter.

The Tram module respiration parameter numeric and waveform data may be affected at levels of 3 volts per meter or greater over the frequency range of 115 to 125 MHz.

Noise may be induced on the CO2 waveform from the CO2 Capnostat modules when the system is used in the presence of an electromagnetic field strength of 3 volts per meter or greater. Measurement accuracy is maintained at a field strength of 3 volts per meter or less.

Users should be aware of known RF sources, such as radio or TV stations and hand-held or mobile two-way radios, and consider them when installing a medical device or system.

Be aware that adding accessories or components, or modifying the medical device or system may degrade the immunity performance. Consult with qualified personnel regarding changes to the system configuration.

General Information

- This manual is an integral part of the product and describes its intended use. It should always be kept close to the equipment. Observance of the manual is a prerequisite for proper product performance and correct operation and ensures patient and operator safety.
- The symbol ⚠ means ATTENTION: Consult accompanying documents.
- Information which refers only to certain versions of the product is accompanied by the model number(s) of the product(s) concerned. The model number is given on the nameplate of the product.
- The warranty does not cover damages resulting from the use of accessories and consumables from other manufacturers.
- GE Medical Systems *Information Technologies* is responsible for the effects on safety, reliability, and performance of the product, only if:
  - assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by GE Medical Systems *Information Technologies*;
  - the electrical installation of the relevant room complies with the requirements of the appropriate regulations; and,
  - the device is used in accordance with the instructions for use.
- All publications conform with the product specifications and applicable IEC publications on safety and essential performance of electromedical equipment as well as with applicable UL and CSA requirements and AHA recommendations valid at the time of printing.
- The GE Medical Systems *Information Technologies* quality management system complies with the international standards DIN EN ISO 9001 and EN 46001, and the Council Directive on Medical Devices 93/42/EEC Annex II.

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For your notes

1 The Basics

For your notes

About This Manual

Manual Purpose

This manual contains the instructions necessary to operate the Solar 8000M patient monitor safely and in accordance with its function and intended use.

Intended Audience

This manual is geared for clinical professionals. Clinical professionals are expected to have a working knowledge of medical procedures, practices, and terminology, as required for monitoring of critically ill patients.

Revision History

Each page of the document has the document part number and revision letter at the bottom of the page. The revision letter changes whenever the document is updated.

Revision	Date	Comments
A	4 June 2001	Initial release of this document, corresponding to software version 3.
B	6 November 2001	Document updated to include Appendix I. Minor editorial changes and corrections were also made.

Manual Conventions

This section describes terminology, standards, and other conventions that are used throughout this manual.

Product References

In this manual:

- The Solar 8000M patient monitor is referred to as the monitor.
- The Clinical Information Center is referred to as the central station.
- The Solar SpO2 module with Masimo SET is referred to as the Masimo module.
- The PRN 50 and PRN 50-M digital writers are referred to as the writers.
- The laser printer is referred to as the printer.
- Collectively, the laser printer and the PRN 50 digital writer are referred to as printers.

Definitions

The following terms are used in this manual to describe various monitor features and functions.

Button — A labeled key located on the keypad or remote control. Press to initiate a process, open a menu, or enter a number.

Menu — Text which appears at the bottom of the display. A menu is composed of a set of menu options.

Menu option — A choice found in a menu. A menu option is enclosed in a rectangle.

Screen text — Any text that appears on the monitor display. In this manual, screen text is shown in italics (for example, *ECG*, *SAVING*, etc.).

Illustrations and Names

All illustrations in this manual are provided as examples only. They may not necessarily reflect your monitoring setup or data displayed on your monitor.

In this manual, all names appearing in examples and illustrations are fictitious. The use of any real person's name is purely coincidental.

Software Packages

The Solar 8000M monitor comes configured with the Basic software package. This package consists of standard-of-care parameters and features required by clinicians caring for acutely ill patients.

Three additional software packages can be purchased separately or in any combination. These packages provide a variety of features which allow the monitor to be configured to best meet the needs of its intended environment.

The Cardiac software package focuses on cardiac conductivity. Its features include full arrhythmia analysis and storage, as well as ST segment trending, storage, and templates. The ability to adjust the ST measurement point is also included in this package.

The Cardiopulmonary software package centers upon cardiac and pulmonary hemodynamics. Features include the PA insert and wedge algorithms, the intra-aortic balloon pump algorithm, and the thermodilution cardiac output algorithm, including predefined computation constants for the catheters of major manufacturers. Also included are cardiac and pulmonary calculations.

The High Resolution CRG Trends package provides storage of up to 100 CRG events, and up to 24 hours of CRG trend data, in addition to the CRG feature set found in the Basic software package.

In this manual, features that are not part of the Basic software package have a note indicating the purchased package in which they are available.

Refer to the appendices for a complete breakdown of the software packages by feature.

How can you tell what software package you have?

1. Select *MORE MENUS* from the monitor's main display.
2. Select *MONITOR SETUP* from the menu displayed.
3. Select *REVISION AND ID* from the Monitor Setup menu. An information window appears. The table below indicates which software package corresponds to the text displayed in the information window.

NOTE

You must select *NEXT* to view Cardiopulmonary Features and High Resolution CRG Trends.

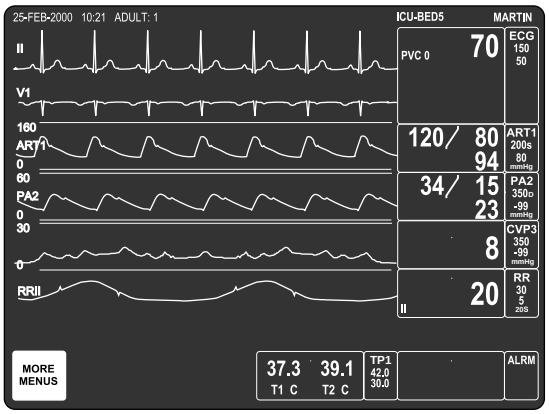
Software Package	Text Displayed in the Information Window
Basic	7020
Cardiac	7025
Cardiopulmonary	Cardiopulmonary Features
High Resolution CRG Trends	High Resolution CRG Trends

Menus

There are several types of menus found on the Solar 8000M monitor. They are described below.

Main Display

The main display shows all monitored parameters and waveforms. It also contains the main menu in the lower left corner of the screen. The main menu consists of one menu option, *MORE MENUS*. You can access menus not related to specific parameters by selecting the *MORE MENUS* option. You can also access parameter menus by selecting the parameter labels. The main display is shown below.



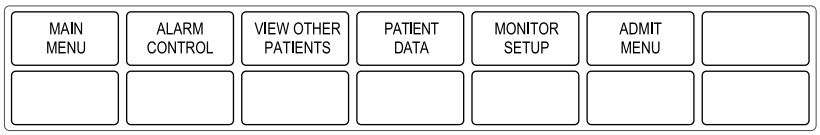
Solar 8000M Main Display

Menu Timeout

The monitor automatically returns to the main display when you have displayed another menu and have not used the Trim Knob control or touchscreen for 5 minutes (default time). This is a monitor default display setting, which can be set for a longer period of time or for no timeout at all. Some menus, such as Vital Signs and Trends, are not affected by the timeout setting. You must exit them using the *MAIN MENU* or *PREVIOUS MENU* option.

More Menus

Selecting the *MORE MENUS* option from the main menu opens the following menu.



521A

- *MAIN MENU* — Returns to the main display with the *MORE MENUS* menu option visible.
- *ALARM CONTROL* — Displays the Alarm Control menu.
- *VIEW OTHER PATIENTS* — Displays the View Other Patients menu.
- *PATIENT DATA* — Displays the Patient Data menu.
- *MONITOR SETUP* — Displays the Monitor Setup menu.
- *ADMIT MENU* — Displays the Admit menu. In Operating Room mode, this option is labeled *NEW CASE SETUP*.

Each of these menus is discussed in more detail in following chapters.

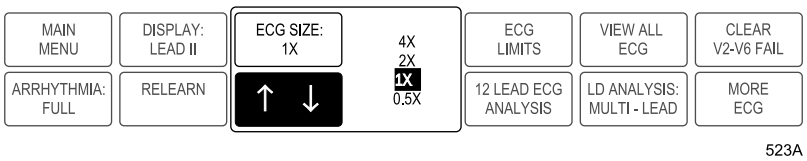
Popup Menus

When some menu options are selected, a small menu “pops up” around the selected menu option. These small menus are called popup menus. The most common types of popup menus are described below.

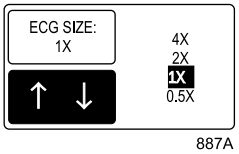
NOTE

With all popup menus, the original menu remains on the screen, but the other options are dimmed. The popup menu must be closed before you can select other options from the original menu.

Frequently in this manual, only the popup menu is shown, rather than the popup menu and the dimmed menu options. Examples of both are shown below.

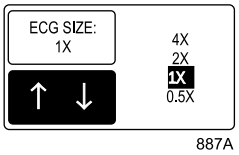


***ECG Size* Popup Menu with Dimmed Menu Options (as it appears on the monitor’s display)**



***ECG Size* Popup Menu Only (as it appears in this manual)**

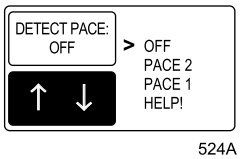
Scrolling Popup Menu



Scrolling Popup Menu

In a scrolling popup menu, all available selections appear, with the current selection highlighted. The Trim Knob control can be rotated, or the touchscreen arrows can be touched, to change the selection. This is called “scrolling.” The new selection is highlighted, and the change appears on the display immediately, allowing the user to see if the selection is appropriate. Pressing the Trim Knob control or touching the anchor menu option selects the highlighted option and closes the popup menu.

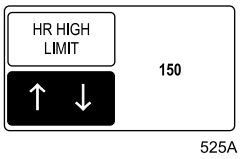
Pointer Popup Menu



Pointer Popup Menu

In a pointer popup menu, all available selections and a pointer (>) appear. The Trim Knob control can be rotated or the touchscreen arrows can be touched to move the pointer to another selection. Pressing the Trim Knob control or touching the anchor menu option implements the change and closes the popup menu.

Numeric Popup Menu



Numeric Popup Menu

Because there are many selections available, only the current selection is displayed in a numeric popup menu. Use the number buttons on the keypad or remote control to enter a new value. Rotating the Trim Knob control or touching the touchscreen arrows also changes the displayed value in the popup menu. You must press the Trim Knob control or touch the anchor menu option to implement the change and close the popup menu.

NOTE

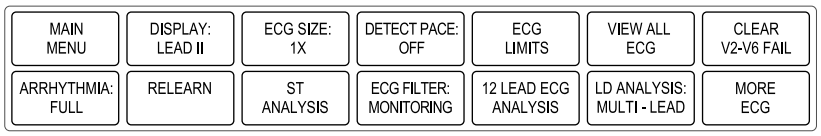
When a numeric popup menu is open, the buttons on the keypad and remote control can only be used to enter numbers. Close the numeric popup menu to access features using these buttons.

Subordinate Menus

In some cases when selecting menu options, a whole new menu is displayed. This is called a subordinate menu.

Below is an example that shows how to access a subordinate menu.

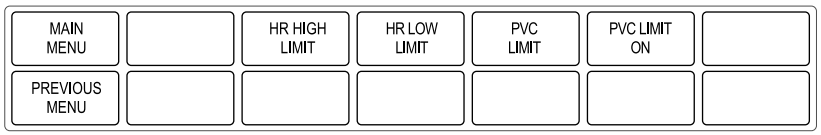
1. Select the *ECG* parameter label to display the ECG menu.



522A

ECG Menu

2. Select *ECG LIMITS*. The entire ECG menu is replaced with the subordinate ECG limits menu.



526A

ECG Limits Menu

3. Select *PREVIOUS MENU* to redisplay the ECG menu.

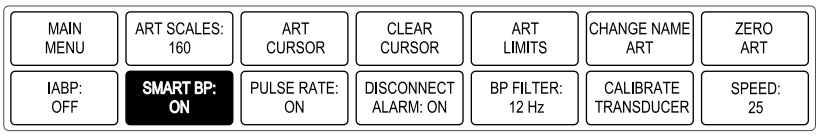
NOTE

Many, but not all, subordinate menus have the *PREVIOUS MENU* option to allow you to return to the previously displayed menu.

Direct Action Menu Options

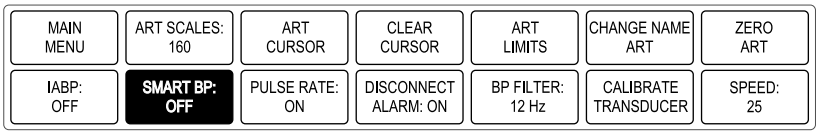
A direct action menu option either turns a feature on or off, or starts a processing function.

Some direct action menu options turn a feature on or off. For example, selecting the *SMART BP: ON* option from the ART parameter menu turns the Smart BP feature off. In on/off cases, the menu option label reflects the current state; selecting it switches to the other state.



527A

SMART BP: ON



528A

SMART BP: OFF

Some direct action menu options start a process. For example, selecting the *RELEARN* option from the ECG parameter menu tells the monitor to immediately relearn the patient's ECG rhythm. These processes cannot be stopped, as they are short-term and stop automatically. Therefore, the menu option label does not change as it does in on/off cases.

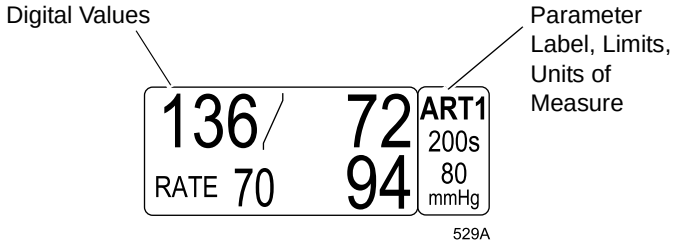
Windows

There are two types of windows found on the Solar 8000M display. They are described below.

Parameter Windows

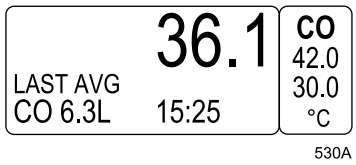
Parameter windows are displayed on the right side of the display, and when necessary, along the bottom of the display. Every monitored parameter has a parameter window.

Each parameter window has two parts, a parameter label and a digital values area. Depending on your default settings, limits and units of measure may be displayed under the parameter label.



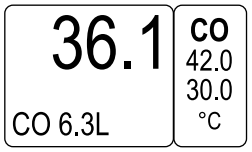
ART Parameter Window

If many parameters are being monitored, some of the parameter windows at the bottom of the display may be reduced in size. Below is an example of a parameter window at its normal size and at its reduced size.



530A

CO Parameter Window, Normal Size



531A

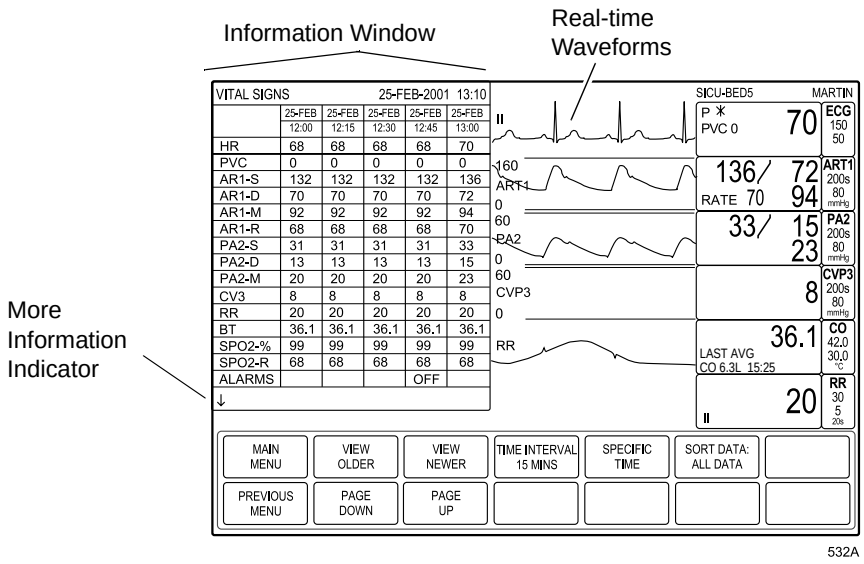
CO Parameter Window, Reduced Size

The parameters that may be displayed at reduced size when positioned at the bottom of the display are: CO, CVP, ICP, LA, RA, RR, SP, SPO2, SVO2, TP, UO, UVC, and VNT.

Information Windows

Information windows are superimposed over the upper left portion of the display. Six parameter windows and two seconds of all real-time waveforms continue to be displayed.

Information windows are displayed when a help option is selected and with certain menu options such as limits. Information windows can contain instructions or other information related to the parameter or menu.



Vital Signs Information Window

Sometimes an information window contains a list, as in the Vital Signs information window shown above. A limited amount of information can be displayed at one time. If there is more information to view, an arrow is displayed at the bottom of the information window.

If a popup menu is displayed with the information window, use the Trim Knob control or touchscreen arrows to scroll to more information. If a menu is displayed, as in the example above, you must select the *PAGE UP* or *PAGE DOWN* option to display more information.

↓ There is more information. Scroll down or use the *PAGE DOWN* option to display more information.

↑↓ You are in the middle of the list. Scroll up or down, or use the *PAGE UP* or *PAGE DOWN* option to display additional information.

↑ You are at the end of the list. Scroll up or use the *PAGE UP* option to display the previous information.

Common Operations

Some monitor operations are used repetitively. Rather than listing the steps to perform each operation every time it appears in this manual, these steps are presented below. Familiarize yourself with the proper procedure for each operation.

Using the Trim Knob Control

The Trim Knob control is found on the keypad and remote control. Refer to Chapter 2, Equipment Overview, for details regarding its location and appearance.

The Trim Knob control is used for highlighting and selecting.

To highlight with the Trim Knob control:

Rotate the Trim Knob control in either direction. This moves the "highlight" (reverse video) on the screen up, down, left, or right to the next option, depending on the type of menu that currently appears on the display.

NOTE

In some cases, rather than highlighted text, a pointer (>) appears in front of the text. When a pointer is present, rotating the Trim Knob control moves the pointer to another option. This is equivalent to highlighting.

To select with the Trim Knob control:

First, highlight your desired menu option (or move the pointer in front of it), as described above. Once you have highlighted the option, press the Trim Knob control once to select it.

NOTE

This manual refers to the Trim Knob operation of highlighting a menu option and then selecting it as "select."

You can also use this procedure to select the parameter labels found in the parameter windows. Simply rotate the Trim Knob control until the parameter label (e.g., *ECG*) is highlighted, then press the Trim Knob control to select it. The corresponding parameter menu will then appear at the bottom of the display.

Using the Touchscreen Display

NOTE

The touchscreen display is an optional feature.

A touchscreen display (or simply touchscreen) is a screen that has areas that are sensitive to touch. These areas are:

- Anywhere inside a parameter window.
- Any menu or menu option.

The touchscreen feature does not function properly if tape or paper is stuck to the screen's surface. Pencils, pens, and other sharp, pointed objects should not be used to activate the touchscreen.

When you have selected a touchscreen item, an audible tone sounds. The volume of this tone can be adjusted in the Setup Default Display menu.

Touching any parameter label opens the parameter menu. Touching *MORE MENUS* on the main display opens a set of menu options used to access menus that are not related to specific parameters.

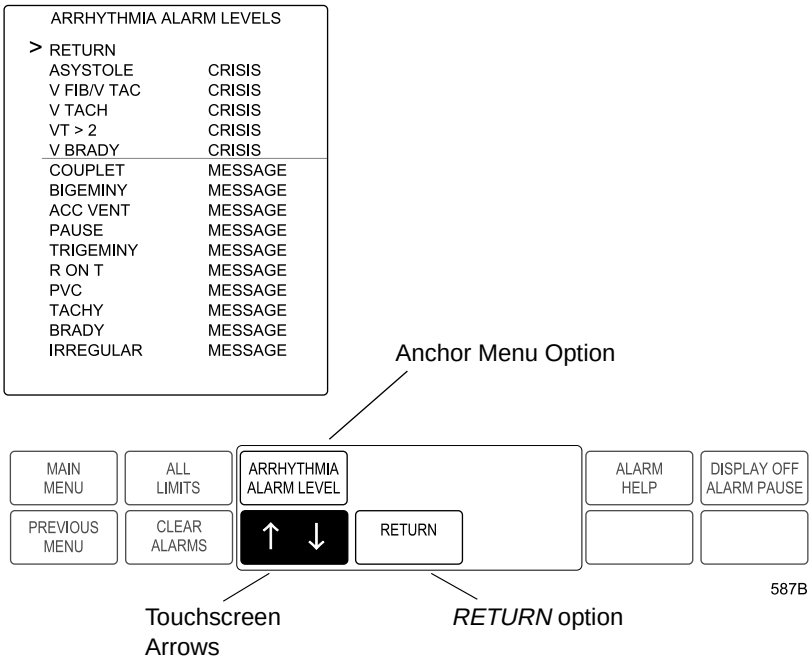
Once a menu is open, you can touch any of the menu options to:

- Open a popup menu.
- Open a popup menu and information window.
- Open a submenu.
- Perform a direct action.

The result of touching a menu option depends on the option selected. Touching a menu option is equivalent to highlighting it by rotating the Trim Knob control, then pressing the Trim Knob control. This manual refers to this process as "selecting."

Using the Touchscreen with Popup Menus and Information Windows

When a menu option is selected (touched), and a popup menu or a popup menu and information window open, touchscreen arrow options and/or a *RETURN* option may appear in the popup menu. In addition, the menu option selected now serves as an anchor menu option and is used as part of the selecting process.



Arrhythmia Alarm Level Popup Menu and Information Window

Touchscreen Arrows

Touchscreen arrows can be touched to move up, down, left, or right. Touching an arrow once will move it to the next option. Touching and holding your touch on an arrow will scroll through the options until you release your touch.

Popup menus may have both the up/down arrows and the left/right arrows, or only one set may appear. The currently active set of arrows is highlighted. Touch the other set to activate it when needed.

For example, in the illustration above, touching the down arrow option once would move the cursor in the information window in front of *ASYSTOLE*.

Anchor Menu Option

Once a popup menu is open, the menu option is referred to as the anchor menu option. For example, in the illustration on the previous page, the *ARRHYTHMIA ALARM LEVEL* option is the anchor menu option.

The anchor menu option can be touched as an equivalent to pressing the Trim Knob control. This is the second step of the "selecting" process. For example, in the illustration on the previous page, after moving the cursor in front of *ASYSTOLE* with the down arrow option, you would touch the *ARRHYTHMIA ALARM LEVEL* anchor menu option. The Asystole alarm level (*CRISIS*) would then be highlighted so the alarm level could be adjusted.

RETURN Menu Option

Touch the *RETURN* menu option in any popup menu to close the popup menu.

When an information window is displayed, touch the *RETURN* menu option in the popup menu at any time to close the information window.

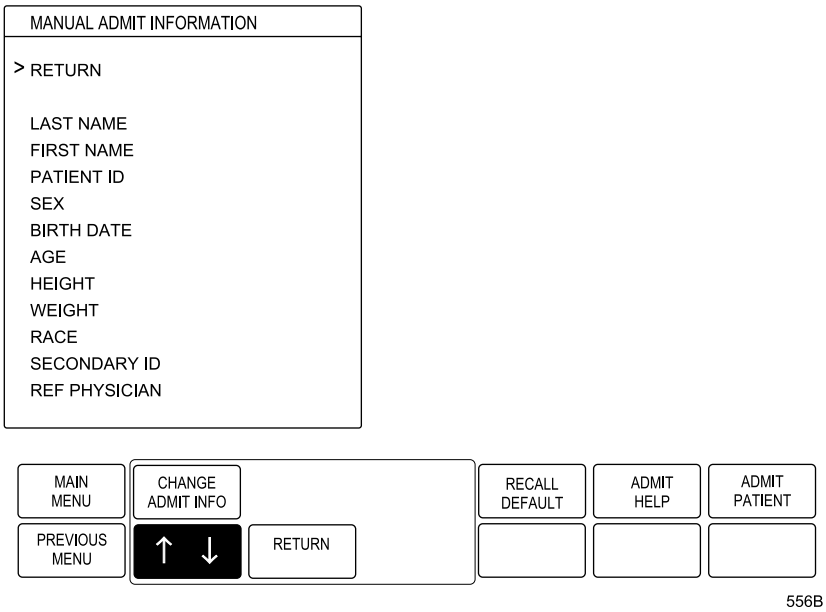
It is also possible to select the *RETURN* option in an information window by using the touchscreen arrows to place the cursor in front of it, then touching the anchor menu option. The information window and popup menu will close. However, the *RETURN* option in the information window is not directly touch sensitive itself. Only the *RETURN* option in the popup menu is directly touch sensitive.

When you are finished making changes, select the RETURN option to clse the popup menu and information window.

Entering Alphanumeric Characters

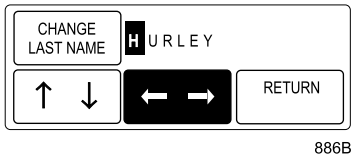
Occasionally, a popup menu or information window requires alphanumeric input, such as patient information or a password. The example below describes how to enter alphanumeric characters when changing admit information. Use the same procedure in other alphanumeric situations.

1. Access the Change Admit Info information window and popup menu:
   a. Select *MORE MENUS* from the main display.
   b. Select *ADMIT MENU*. An information window and a new menu are displayed.
   c. Select *CHANGE ADMIT INFO* from the menu. A popup menu opens.



Change Admit Info Popup Menu and Information Window

2. Move the cursor in front of *LAST NAME*, then press the Trim Knob control or touch the *CHANGE ADMIT INFO* option to select it. If a name has already been entered, the selected name appears in the Change Last Name popup menu, as shown below.



Change Last Name Popup Menu

3. Select the first character block by rotating, then pressing the Trim Knob control, or by using the touchscreen arrows.
4. To scroll through the alphanumeric characters, rotate the Trim Knob control in either direction or use the up/down touchscreen arrows. Press the Trim Knob control when the desired character appears.

NOTE

It is not necessary to touch the anchor menu option or press the Trim Knob control when using the touchscreen. Simply use the left/right arrow keys to move to the next character block after you have reached the desired character.

5. After the character is selected, move to the next character block and repeat the procedure.
6. Continue until you have entered all the characters.

NOTE

Alphanumeric popup menus have character limits. In this manual, these limits are indicated wherever such popup menus are described.

7. Select the *CHANGE LAST NAME* option with the Trim Knob control or touchscreen. You can then select another option from the information window, if desired.
8. When you are finished making changes, select the *RETURN* option to close the popup menu and information window.

NOTE

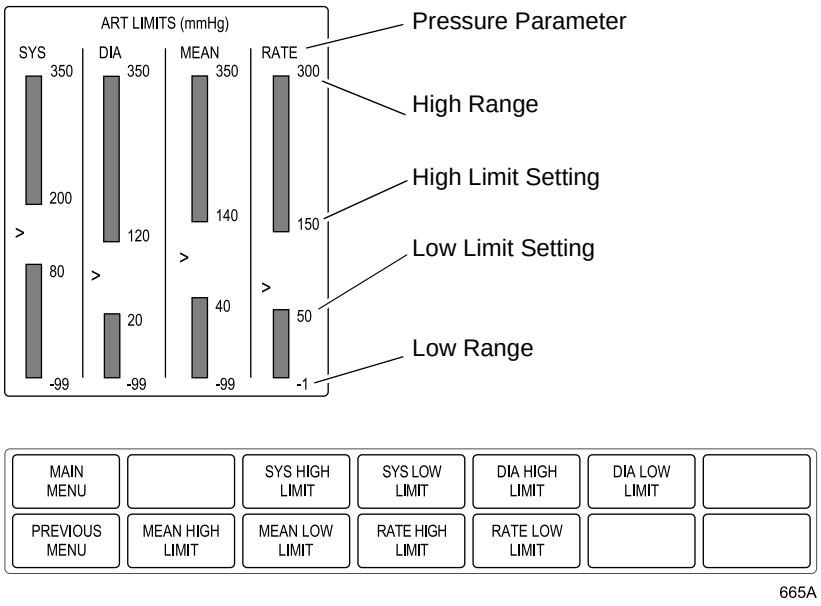
When no information window appears on the display, step 8 is not necessary. Upon selecting the menu option in the popup menu (step 7), the popup menu closes and function of the Trim Knob control returns to the menu.

Setting Alarm Limits

Each parameter menu has an option to set the alarm limits for the monitored aspects of that parameter. The monitor's response when a limit is violated depends on the alarm level for which the parameter is set. Refer to Chapter 8, Alarm Control, for details on the alarm levels and the monitor's response.

Regardless of the parameter, all alarm limits are adjusted in the same way. The procedure below describes how to set alarm limits for the ART parameter. Follow this procedure to set all other parameter alarm limits.

1. Select the *ART* parameter label. The ART menu appears at the bottom of the screen.
2. Select the *ART LIMITS* option from the ART menu. An information window and a new set of menu options are displayed.



ART Limits Menu and Information Window

The information window shows the limit ranges and the current set limits. The pointer (>) indicates the current value of that parameter for the monitored patient. The pointer moves as the current value of that parameter changes.

3. To change a limit, for example, the Rate High Limit, select the *RATE HIGH LIMIT* option from the limits menu. A popup menu opens, displaying the current limit.
4. You can enter a new limit value in three different ways:
   a. Use the number buttons on the keypad or remote control.
   b. Rotate the Trim Knob control.
   c. Use the touchscreen arrows to change the value.

   The bar graph in the information window is adjusted to show the new limit.

   If a value entered for one limit exceeds the opposite limit for the same parameter, the value will be ignored. For example, using the limits shown in the illustration on the previous page, if you were to enter a value of 40 for the *RATE HIGH LIMIT*, it would be ignored because the *RATE LOW LIMIT* is set to 50.

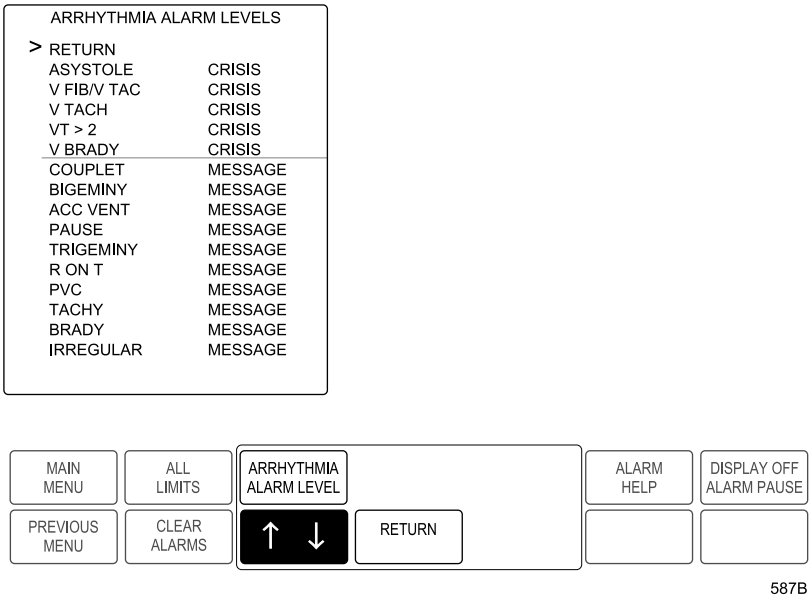
   Regardless of the method used to enter a new value, the limit will not be in effect until you press the Trim Knob control or touch the Rate Limit menu option (anchor menu option), closing the popup menu.
5. Follow this procedure to set any other parameter limits in this menu.
6. When you are finished, select *PREVIOUS MENU* to exit the limits menu and return to the parameter menu.

Selecting Options from Scroll Lists

Various features of the monitor can be set up using scroll lists. In a scroll list, the currently selected option is the only one shown. However, selecting the option and then rotating the Trim Knob (or using the touchscreen arrows) allows you to scroll through the other choices and select one, if desired.

For example, the Arrhythmia Alarm Levels information window uses scroll lists to set the alarm level for each arrhythmia call. The steps below demonstrate how to select and change an option in the Arrhythmia Alarm Levels information window. In this example, *V BRADY* is changed from a Crisis level to a Warning level.

1. Access the Arrhythmia Alarm Level popup menu and information window by selecting *MORE MENUS* from the main display. Select *ALARM CONTROL* from the menu that appears, then select *ARRHYTHMIA ALARM LEVEL*. The Arrhythmia Alarm Level popup menu and information window open.



Arrhythmia Alarm Level Popup Menu and Information Window

2. Rotate the Trim Knob control or use the touchscreen arrows to move the pointer (>) next to *V BRADY*.
3. When the pointer is next to *V BRADY*, push the Trim Knob control or touch the *ARRHYTHMIA ALARM LEVEL* menu option (anchor menu option). The alarm level (in this case *CRISIS*) for *V BRADY* highlights.
4. Rotate the Trim Knob control or use the touchscreen arrows to scroll through the options.
5. When *WARNING* is displayed, press the Trim Knob control or touch the *ARRHYTHMIA ALARM LEVEL* menu option (anchor menu option) to complete the change. The change takes effect immediately, and the information window remains open to make other changes.
6. When you are finished making changes, select *RETURN* to close the information window.

For your notes

2 Equipment Overview

For your notes

Components

Solar 8000M Patient Monitoring System

The Solar 8000M monitoring system consists of the following standard components:

- Solar 8000M processing unit
- Display
- Keypad and/or remote control
- Acquisition module(s)
- Tram-rac housing

Additional, optional components include:

- Touchscreen display
- Clinical Information Center (central station)
- Remote display
- Writer or printer
- Octanet connectivity device

The components of the system are discussed and illustrated on the following pages. For complete setup information, refer to the service manual.

Solar 8000M Processing Unit

Connectors are located on the processing unit. Patient data is displayed on a separate display unit.

Front View of the Processing Unit

M-Ports

The number of M-ports is dependent on the software package(s) purchased.

- When the Basic software package is purchased, the processing unit comes with three M-ports (the leftmost connector shown above is plugged).
- With the purchase of the Cardiac software package in addition to the basic package, all four M-ports are available (see figure above).

NOTE

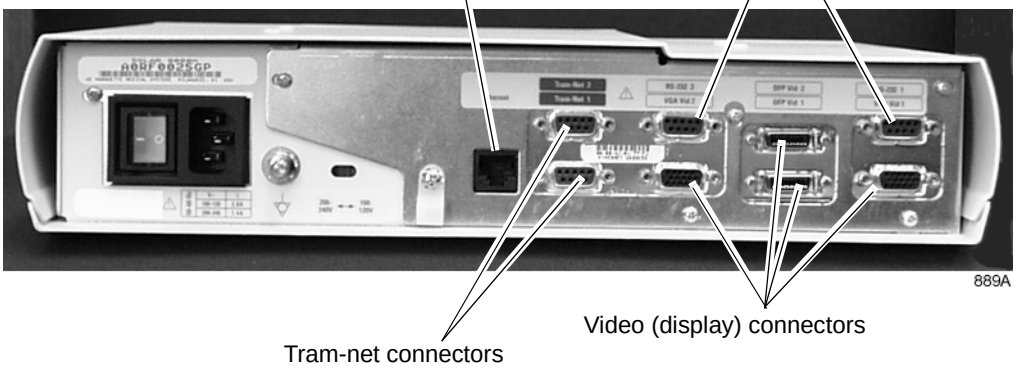
In the above figure, the keypad is connected to the fourth M-port; therefore it is not visible.

The following devices can be directly connected to the M-ports:

- Solar 8000M keypad
- Solar 8000M remote control
- PRN 50-M digital writer
- Respiratory mechanics module (RM-M module)
- RAMS M-200 system

NOTE

If the PRN 50 writer, respiratory mechanics module, or RAMS system does not function when connected to an M-port, you may need an AutoPort to M-port adapter. Refer to Chapter 7, Printing, for connection information for the PRN 50 writer, and to the Solar 8000M Patient Monitor Service Manual for additional information about all three devices.



NOTE

The number of video connectors varies by configuration.

Back View of the Processing Unit

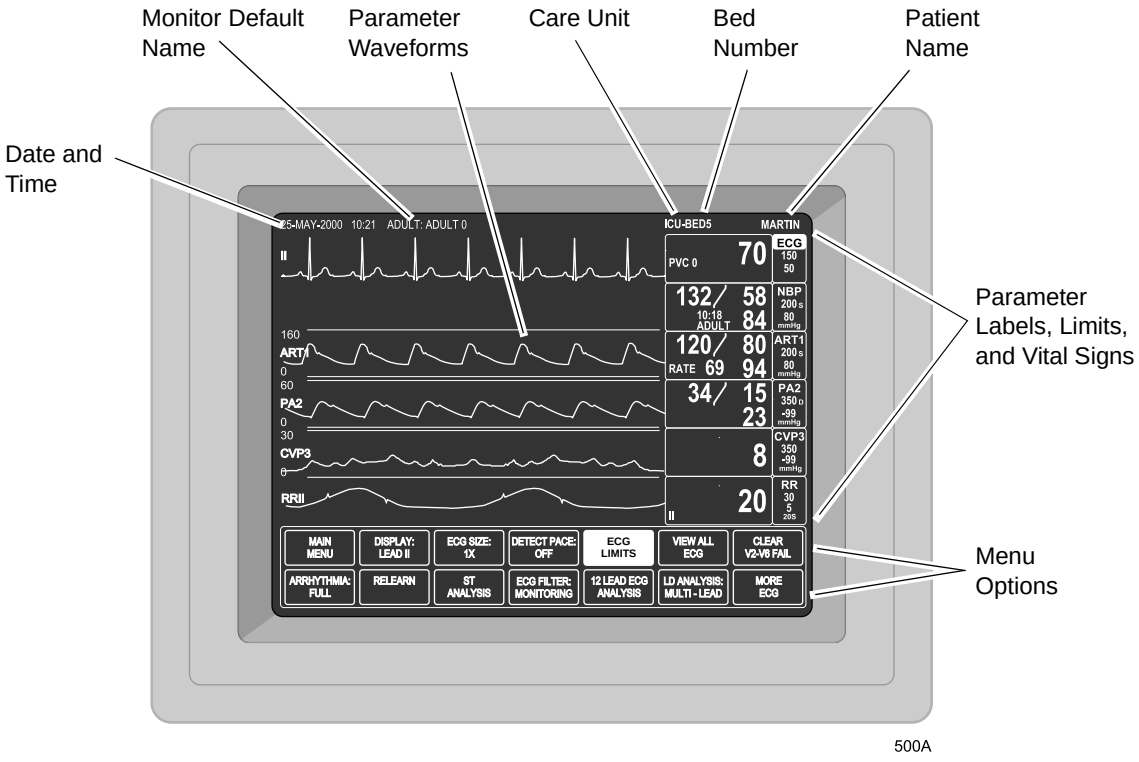
Solar 8000M Display Unit

The Solar 8000M display unit is connected by cable to a video connector on the processing unit. A selection of different color displays is offered to accommodate different needs.

WARNING
Do not connect a monochrome display to the Solar 8000M monitor. Visual alarm indicators may not appear properly.

Display Items

Regardless of the size or type of display unit you have, the display items are the same. The illustration below shows a typical display with items labeled.



Solar 8000M Display Items

Tram Modules

The Tram module is an acquisition module that collects the patient's physiological data and sends it to the monitor for display. Tram modules are multi-parameter acquisition modules. Multi-parameter modules are capable of monitoring more than one parameter simultaneously, e.g., ECG, SpO2, and NBP.

The type of Tram module determines what parameters it monitors. A label on the front of the monitor identifies the type of module.

Tram 451N Module

These series of Tram modules are discussed in this document:

- Tram x00
- Tram x00A
- Tram x00SL
- Tram x50SL
- Tram x51
- Tram x51M
- Tram x51N

The "x" refers to the "hundred series" number of the module, e.g., Tram 600SL, Tram 851N.

Tram x51 Series Modules

The x51 series is the current series of Tram modules. Refer to the table below to determine your Tram x51 series module's monitoring features.

Tram Module	12-Lead ECG Analysis	Resp	Temp/CO	Dinamap NBP	Invasive BP	GE SpO2†	Masimo SpO2†	Nellcor SpO2†	Defib/ Sync‡
451	✓	✓	✓	✓	3/4*	✓			✓
451M	✓	✓	✓	✓	3/4*		✓		✓
451N	✓	✓	✓	✓	3/4*			✓	✓
851	✓	✓	✓	✓		✓			✓
851M	✓	✓	✓	✓			✓		✓
851N	✓	✓	✓	✓				✓	✓

* A Y-adapter cable is required to monitor four invasive blood pressures.

† Different SpO2 cables are required for each type of SpO2 processing. The cable connectors are not interchangeable.

‡ The Defib Sync connector on x51 series modules requires a DIFFERENT cable than the other Tram module series. They are not interchangeable. The cable for the x51 series modules has a 7-pin connector.

Tram Module Y-Adapter Cable

The Tram 451 series modules can monitor four invasive blood pressures when a Y-adapter cable is used. This cable plugs into the **BP3** connector on the module, and allows two separate invasive blood pressures to be monitored from that connector.

Tram 451N Module with Y-Adapter Cable Connected to BP3 Connector

This cable is designed to fit only in the **BP3** connector. Do not attempt to plug it into any other connector; it will not function.

The Y-adapter cable can ONLY be used with Tram 451 series modules. It cannot be used with any other Tram module series.

Other Tram Module Series

There are several other series of Tram modules. Refer to the table below to determine the monitoring features of your non-x51 series module.

Tram Module	12-Lead ECG Analysis	Resp	Temp/CO	NBP*	Invasive BP	SpO2	Defib/ Sync
100A		✓	✓	✓	2		✓
200A		✓	✓	✓	2	✓	✓
200SL	✓	✓	✓	✓	2	✓	✓
250SL	✓	✓	✓	✓	2	✓	✓
400A		✓	✓	✓	3	✓	✓
400SL	✓	✓	✓	✓	3	✓	✓
450SL	✓	✓	✓	✓	3	✓	✓
500A		✓	✓		4		✓
600A		✓	✓		4	✓	✓
600SL	✓	✓	✓		4	✓	✓
650SL	✓	✓	✓		4	✓	✓
800A		✓	✓	✓		✓	✓
800SL	✓	✓	✓	✓		✓	✓
850A		✓	✓	✓		✓	✓
850SL	✓	✓	✓	✓		✓	✓

***** Tram module software versions 10B and later use the Dinamap NBP algorithm. Software versions 10A and earlier use the GE Medical Systems *Information Technologies* NBP algorithm.

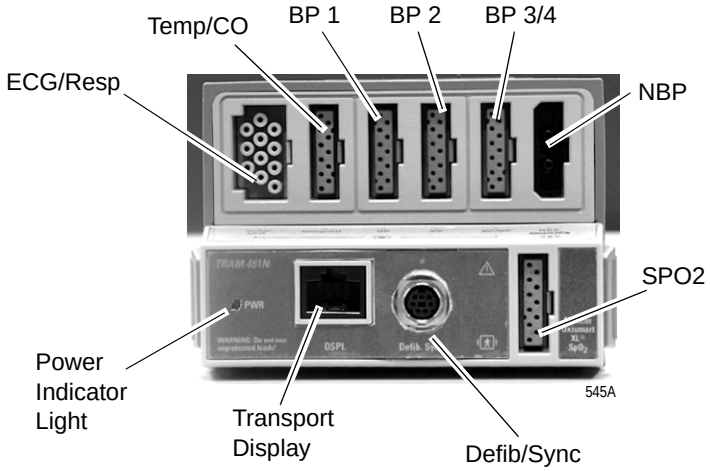
Tram x00, x00A, and x00SL modules with SpO2 are compatible with Ohmeda probes.

Tram x50SL modules are compatible with Nellcor and GE Medical Systems *Information Technologies* probes.

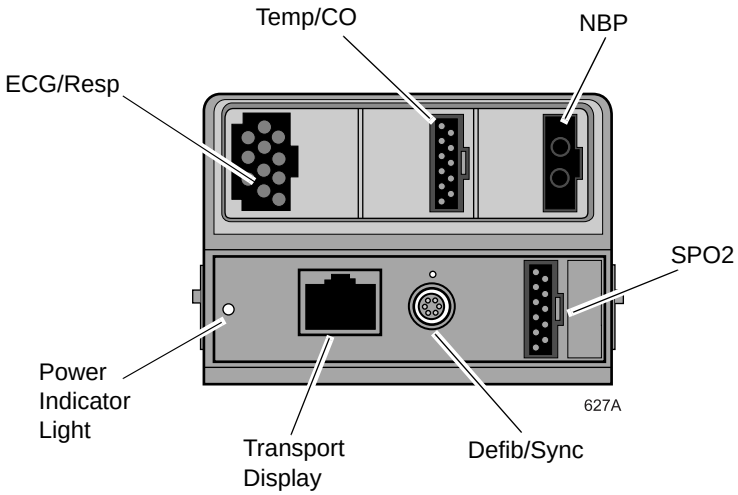
Although not shown in the table above, Tram x00 modules have the same features as the x00A modules. However, Tram x00 modules are not compatible with the selectable lead, 3-lead ECG cable.

Tram Module Front Panel Connectors

Below are two examples of Tram modules. The connectors on the front of the module are labeled. Some Tram modules have different NBP and SPO2 connectors, but they are located in the same position as those shown below.



Front Panel of Tram 451N Module



Front Panel of Tram 850SL Module

The Defib/Sync connector provides analog output signals (an ECG signal and a blood pressure signal, if available) to user-supplied equipment. A 5-volt, 2-millisecond artificial pacer spike is added to the analog output when *PACE* is on and detection occurs. Refer to Chapter 21, Appendices, for details on signal outputs, and to the Tram module service manual for signal connector pin configuration.

Single-Parameter Modules

Single-parameter acquisition modules also collect the patient's physiological data and send it to the monitor for display. Single parameter acquisition modules are available to monitor a wide variety of parameters, such as ECG, BP, NBP, CO2, SpO2, and SvO2.

Single-Parameter ECG/Resp Module

Single-parameter modules can be used for ECG acquisition in place of the multi-parameter Tram module. There are four different single-parameter ECG/Resp modules. The chart below shows the features of each.

ECG/Resp Module Features

Module	12-Lead ECG Analysis	Resp	Defib/Sync
ECG/RESP	No	Yes	No
ECG/RESP	No	Yes	Yes*
ECG/RESP SL	Yes	Yes	No
ECG/RESP SL	Yes	Yes	Yes*

*There is a Defib Sync connector on the modules that have this feature.

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Front Panel of ECG/Resp SL Module with Defib Sync

Status Indicator Light

There is a **STATUS** indicator light on each ECG/Resp module. A green status light indicates a normal condition.

If the status light is yellow, check for system compatibility:

- Verify that the monitor is a Solar monitor.
- Verify that the Tram-rac housing is a Tram-rac 4A housing.

If you can verify both of these, call your biomedical department for further assistance.

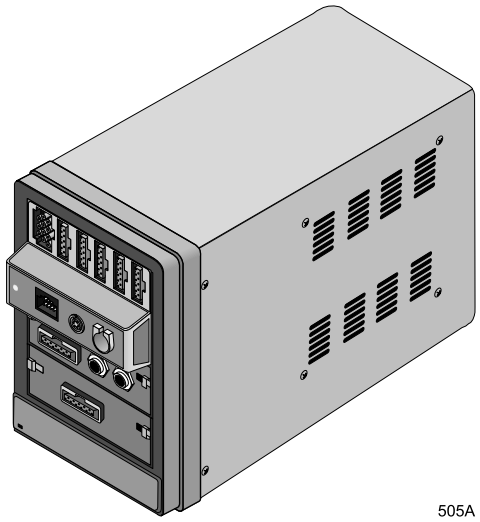
Defib Sync Connector

The **DEFIB. SYNC.** connector provides analog output signals to user-supplied equipment. A 5-volt, 2-millisecond artificial pacer spike is added to the analog output when *PACE* is on and detection occurs. Refer to Chapter 21, Appendices, for details on signal outputs, and to the appropriate module service manual for signal connector pin configuration.

Tram-rac Housing

The Tram-rac housing holds the Tram module and other GE Medical Systems *Information Technologies* parameter modules. The housing is connected by cable to the monitor, using a Tram-net connector.

The Tram-rac 2 housing holds one Tram module. The Tram-rac 4A housing holds one Tram module plus two parameter modules.



Tram-rac 4A Housing

Multiple Housings

You can connect an additional housing to a Tram-rac 4A housing to allow for monitoring additional parameters. Refer to the Tram-rac 4A service manual for details on setup.

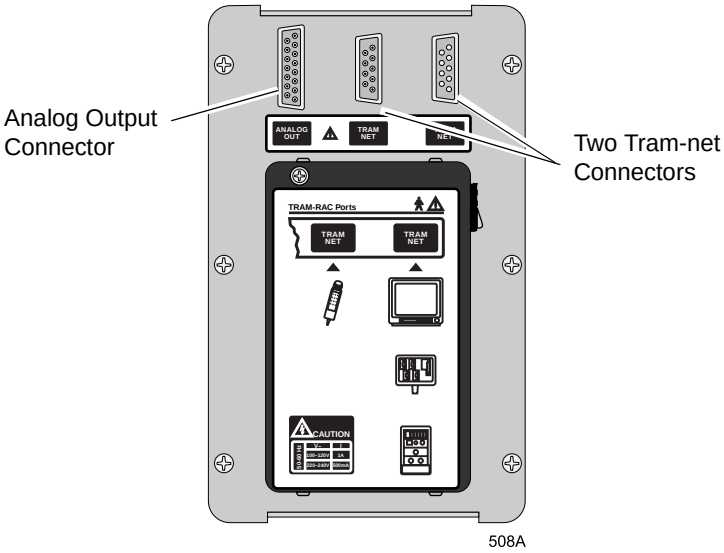
When using two housings, follow these guidelines:

- One housing must have a power supply.
- Only one ECG source module can be used.
- If the second housing is NOT a Tram-rac 4A housing, the Tram module must go in the second housing.
- Single-parameter BP and temp modules can only be placed in the bottom two positions of a housing.

Housing Connectors

All housings have a Tram-net connector. Except for the Tram-rac 2 housing, all housings also have an analog output connector. The analog output connector provides data from the monitor to other user-supplied equipment. (Refer to Chapter 21, Appendices, for details.) Depending on the type of Tram-rac housing, the connectors may be located on the front, the back, or both.

The Tram-net connectors are on the back panel.

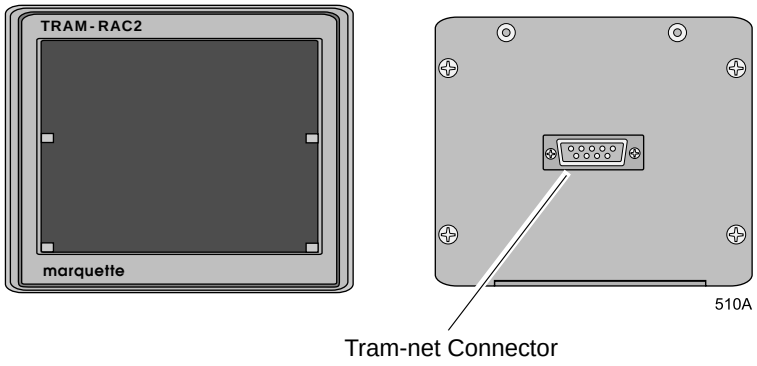


Back Panel of Tram-rac 4A Housing

NOTE

The Solar ECG module does not support analog output from the Tram-rac analog output connector. When using the Solar ECG module, analog output is only available from the optional Defib Sync connector on the front of the module.

The Tram-rac 2 housing does not have an analog output connector. The Tram-net connector is on the back.

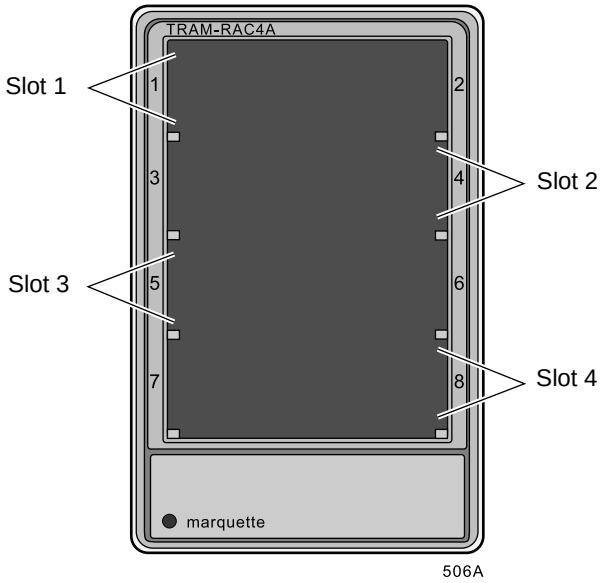


Front and Back Panels of Tram-rac 2 Housing

Features of the Housing

The housing has “slots,” which are used to hold modules. Modules occupy either one or two slots. All Tram modules occupy two slots, and must be placed in the top two slots of the housing.

There are numbers on each side of each slot on the housing. These numbers have significance when duplicate parameters are being monitored. The number displayed with the parameter label on the monitor — i.e., *ART1*, *PA2* — indicates that the module is in the same-numbered slot. For example, if you have an *ART5* parameter label on the monitor, this means that a pressure module is in slot 3, and an ART line is connected to that module.



Tram-rac Housing Slots

Installing and Removing Modules

Acquisition modules are easily installed and removed. A Tram module must always occupy the top position in the Tram-rac housing. Other modules are installed below it.

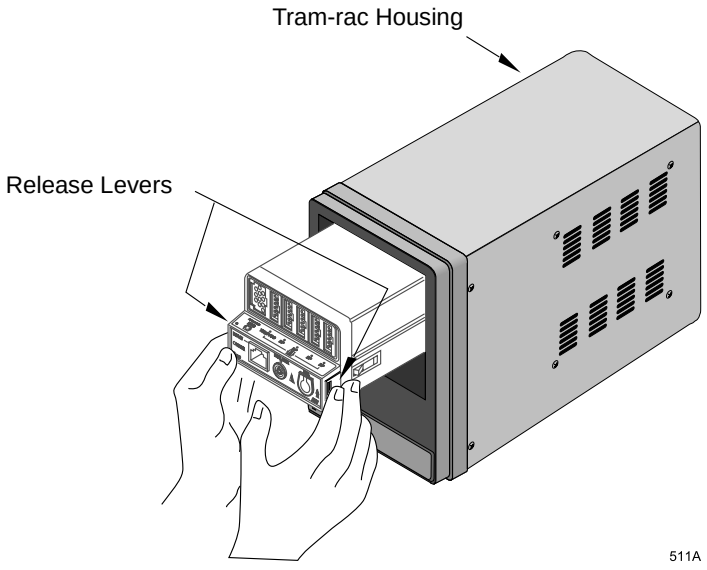
To install a module:

1. Facing the Tram-rac housing, guide the back of the module into the appropriate position.
2. Gently push the module into the housing. You will hear a click when the module is fully inserted.

To remove a module:

1. Push the module into the Tram-rac housing. This releases the module and makes it easier to remove.
2. Press and hold the release levers found on each side of the front of the module.
3. Pull the module out about 6 inches (15 cm).
4. Grasp the module firmly with both hands and remove it. Do not try to hold the module by the release levers.

   The release levers for Tram modules are recessed in the side of the protruding front of the module.



Removing a Tram Module

Optional Clinical Information Center

The Unity Network (Ethernet) establishes communication and allows patient data to be sent to an optional Clinical Information Center (central station). Refer to the Clinical Information Center Operator's Manual for operating instructions.

Clinical Information Center

Optional Writers and Printers

For information about writers and printers available for the Solar 8000M monitor, refer to Chapter 7, Printing.

Optional Remote Display

An optional remote display can be connected to the system to provide enhanced visibility.

Optional Octanet Remote Connectivity Device

For information about the Octanet remote connectivity device, refer to Chapter 20, Interfaces.

Controls

Keypad

The Solar 8000M monitor keypad has a Trim Knob control, as well as 18 buttons that can be used to access various operational features of the monitor. Some buttons are also labeled with numbers, and can be used for direct numeric data entry.

The keypad may be connected to the front of the Solar 8000M processing unit, or it may be mounted in another convenient location using the optional wall-mount holster (not shown) and connected by cable to the processing unit.

There are three versions of the keypad: Adult, Neonatal, and Operating Room. Each version features buttons that allow easy access to commonly performed functions for that mode. For example, the Neonatal keypad has CRG buttons, while the Operating Room keypad has Airway Gases buttons. The Operating Room keypad is shown below.

NOTE

The message *WARNING: REMOTE MISMATCHED WITH MONITORING MODE* is displayed if the keypad type does not match the monitoring mode. For example, if an Operating Room keypad were connected to a monitor set for the Adult-ICU monitoring mode, this message would appear. However, the monitor and keypad will continue to function.

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Solar 8000M Remote Keypad — Operating Room

Trim Knob Control

Operation of the Trim Knob control is described in Chapter 1, The Basics.

Buttons

The table below shows the buttons that appear on the keypads. It also indicates which type(s) of keypad the button appears on, and gives a brief description of its function.

Button	Keypad Type(s)	Function
12-Lead	Adult	Opens the 12 Lead ECG Analysis menu.
Admit/Discharge	Adult, Neonatal	Opens a menu to admit or discharge a patient.
Airway Gases: CO2	Operating Room	Opens the CO2 menu.
Airway Gases: Gas	Operating Room	Opens the Gas menu.
Alarm Volume	Neonatal	Opens a menu to adjust the audio alarm volume.
All Limits	Adult, Neonatal	Opens the All Limits menu to adjust the limits of currently monitored parameters.
Cardiac Calcs	Adult, Operating Room	Opens the Cardiac Calcs menu.
Cardiac Output	Adult, Operating Room	Opens the Cardiac Output menu.
CRG Events	Neonatal	Opens the Document CRG Events window.
CRG Print	Neonatal	Prints the CRG waveforms.
CRG Recall	Neonatal	Opens the CRG Trends menu at the most recent CRG event.
Defaults	Adult, Neonatal, Operating Room	Opens the defaults menu.
Display On/Off	Adult, Neonatal, Operating Room	Turns the monitor display and audio items off and on. Operating power (mains) is still on, and alarms remain active at the central station. Also turns NBP off.
Dose Calcs	Neonatal	Enters the dose calculations program.
Graph Go/Stop	Adult, Neonatal, Operating Room	Initiates a graph run of patient data. Press the button again to stop.
Graphic Trends	Adult, Operating Room	Opens the Graphic Trends menu.
Main Menu	Adult, Neonatal, Operating Room	Returns to the main display.

Button	Keypad Type(s)	Function
NBP Auto	Adult, Operating Room	Opens the NBP Auto menu.
NBP Go/Stop	Adult, Neonatal, Operating Room	Initiates an NBP measurement. Pressing this button while a measurement is in process stops that measurement.
NBP Stat	Adult, Operating Room	Starts five minutes of continuous, sequential NBP measurements.
New Case	Operating Room	Performs the direct action of discharging and then immediately admitting a patient.
PA Wedge	Adult, Operating Room	Opens the PA Wedge menu.
QRS Volume	Neonatal	Opens a menu to adjust the volume of the QRS tone.
Resp Relearn	Neonatal	Starts a relearn of the patient's respiration.
Silence Alarm	Adult, Neonatal, Operating Room	Refer to "Controlling Audio Alarms" on page 8-7 for important information on the function of this button.
SpO2	Operating Room	Opens the SpO2 menu.
Tabular Trends	Operating Room	Opens the Tabular Trends menu.
View Other	Adult, Neonatal	Opens the View Other Patients menu.
Vital Signs	Adult, Neonatal	Opens the Vital Signs menu.
Zero All	Adult, Neonatal, Operating Room	Zeros all invasive pressure lines that are open to atmosphere.

Remote Control

A hand-held remote control is also available. This can be used in addition to, or instead of the keypad, allowing the clinician a greater range of movement while operating the monitor. Like the keypad, the remote control contains a Trim Knob control and 18 function buttons. It is also available in three versions, Adult, Neonatal, and Operating Room.

All functions of the remote control are identical to those of the corresponding keypad. Refer to the Keypad section in this chapter for details.

An optional holster, shown below, is also available for convenient storage of the remote control.

Solar 8000M Remote Control — Adult

Putting the Monitor Into Operation

Monitor Installation and Connection

WARNING
Before using the monitor for the first time, read the information in Chapter 3, Safety.

- The operating position of the processing unit does not influence the performance of the monitor in any way.
- Choose a location that affords an unobstructed view of the display and easy access to the operating controls.
- Set up the monitor in a location that affords sufficient ventilation. The ventilation openings of the device must not be obstructed (by equipment, walls, or blankets, for example).
- The ambient conditions specified in the technical specifications must be ensured at all times.
- The monitor is designed to comply with the requirements of IEC 60601-1/EN 60601-1.
- Using the power cord supplied with the monitor, connect it to the power line. Use only the original cord.

WARNING
To reduce the risk of electric shock, the monitor must only be connected to a properly installed power outlet with protective ground contacts.

- For measurements in or near the heart, we recommend connecting the monitor to the potential equalization system. Use the green and yellow potential equalization cable and connect it to the pin labeled with the ⏚ symbol.
- GE Medical Systems *Information Technologies* service is available to connect the monitor to the Unity network (for use with a Clinical Information Center, a QS system, a MUSE system, etc.).

WARNINGS

For safety reasons, all connectors for patient cables and sensor leads are designed to prevent inadvertent disconnection, should someone pull on them. Do not route cables in a way that they may present a stumbling hazard. For devices installed above the patient, adequate precautions must be taken to prevent them from dropping on the patient.

After connecting the monitor to the clinical information center, verify the function of the alarm system. This can be done, for instance, by temporarily changing one of the alarm limits to initiate an alarm.

Turning Power On

The monitor is preset at the factory for a specific AC voltage. Before applying power, be sure that the power requirements match your power supply. Refer to the label on the back of the processing unit for voltage and current requirements. Also refer to Chapter 3, Safety, for power requirements.

When all cables are properly connected, press the power switch on the processing unit to the "**I**" (on) position. Also turn power on to the display. After approximately 10 seconds, a display should appear on the monitor.

Solar 8000M Processing Unit

Performance Check

After turning the monitor on, and during operation, the monitor runs automatic self-tests. If a malfunction is detected, the monitor displays a message and a prompt, asking if the user wishes to continue operation.

WARNING
If the "*DO YOU WISH TO CONTINUE?*" message appears during monitor operation, it is the physician's responsibility to decide if the unit is still suitable for patient monitoring. As a general rule, monitoring with this unit should continue only in extremely urgent cases and under the supervision of a physician. The unit must be repaired before being used on a patient again. If this message appears after power-up, the unit must be repaired before being used on a patient.

3 Safety

For your notes

For Your Safety

Intended Use

The intended use of this monitoring system is to monitor physiological parameter data on adult, pediatric, and neonatal patients within a hospital or facility providing patient care.

Physiological data includes the parameters covered in this manual. The monitoring system is also intended to provide physiological data over the Unity network to clinical information sytems. This information can be displayed, trended, stored, and printed.

Terminology

The terms danger, warning, and caution are used throughout this manual to point out hazards and to designate a degree or level or seriousness. Familiarize yourself with their definitions and significance.

Hazard is defined as a source of potential injury to a person.

DANGER indicates an imminent hazard which, if not avoided, will result in death or serious injury.

WARNING indicates a potential hazard or unsafe practice which, if not avoided, could result in death or serious injury.

CAUTION indicates a potential hazard or unsafe practice which, if not avoided, could result in minor personal injury or product/property damage.

NOTE provides application tips or other useful information to assure that you get the most from your equipment.

Monitor Safety

The safety statements presented in this chapter refer to the equipment in general and, in most cases, apply to all aspects of the monitor. There are additional safety statements in the parameter chapters which are specific to that monitored parameter.

The order in which safety statements are presented in no way implies order of importance.

Dangers

There are no dangers that refer to the equipment in general. Specific "Danger" statements may be given in the respective sections of this manual.

Warnings

WARNINGS

ACCIDENTAL SPILLS — To avoid electric shock or device malfunction liquids must not be allowed to enter the device. If liquids have entered a device, take it out of service and have it checked by a service technician before it is used again.

ACCURACY — If the accuracy of any value displayed on the monitor, central station, or printed on a graph strip is questionable, determine the patient's vital signs by alternative means. Verify that all equipment is working correctly.

ALARMS — Do not rely exclusively on the audible alarm system for patient monitoring. Adjustment of alarm volume to a low level or off during patient monitoring may result in a hazard to the patient. Remember that the most reliable method of patient monitoring combines close personal surveillance with correct operation of monitoring equipment.

After connecting the monitor to the central station, nurse-call system, and/or network, verify the function of the alarm system.

The functions of the alarm system for monitoring of the patient must be verified at regular intervals.

WARNINGS

BEFORE USE — Before putting the system into operation visually inspect all connecting cables for signs of damage. Damaged cables and connectors must be replaced immediately.

Before using the system, the operator must verify that it is in correct working order and operating condition.

Periodically, and whenever the integrity of the product is in doubt, test all functions.

CABLES — Route all cables away from patient's throat to avoid possible strangulation.

CONDUCTIVE CONNECTIONS — Extreme care must be exercised when applying medical electrical equipment. Many parts of the human/machine circuit are conductive, such as the patient, connectors, electrodes, transducers. It is very important that these conductive parts do not come into contact with other grounded, conductive parts when connected to the isolated patient input of the device. Such contact would bridge the patient's isolation and cancel the protection provided by the isolated input. In particular, there must be no contact of the neutral electrode and ground.

DEFIBRILLATION — Do not come into contact with patients during defibrillation. Otherwise serious injury or death could result.

DISCHARGE TO CLEAR PATIENT DATA — When admitting a new patient, you must clear all previous patient data from the system. To accomplish this, disconnect patient cables (if you use a Tram module be sure the module is locked in place in the Tram-rac housing) then do a discharge.

DISCONNECTION FROM MAINS — When disconnecting the system from the power line, remove the plug from the wall outlet first. Then you may disconnect the power cord from the device. If you do not observe this sequence, there is a risk of coming into contact with line voltage by inserting metal objects, such as the pins of leadwires, into the sockets of the power cord by mistake.

WARNINGS

DISPOSAL — Dispose of the packaging material, observing the applicable waste control regulations and keeping it out of children's reach.

EXPLOSION HAZARD — Do not use this equipment in the presence of flammable anesthetics, vapors or liquids.

INTERFACING OTHER EQUIPMENT — Devices may only be interconnected with each other or to parts of the system when it has been determined by qualified biomedical engineering personnel that there is no danger to the patient, the operator, or the environment as a result. In those instances where there is any element of doubt concerning the safety of connected devices, the user must contact the manufacturers concerned (or other informed experts) for proper use. In all cases, safe and proper operation should be verified with the applicable manufacturer's instructions for use, and system standards IEC 60601-1-1/EN 60601-1-1 must be complied with.

INTRACARDIAC APPLICATION — When applying devices intracardially, electrically conductive contact with parts connected to the heart (pressure transducers, metal tube connections and stopcocks, guide wires, etc.) must be avoided in all cases.

To prevent electrical contact, we recommend the following:

- always wear isolating rubber gloves,
- keep parts that are conductively connected to the heart isolated from ground,
- if possible, do not use tube fittings or stopcocks made of metal.

During intracardiac application of a device, a defibrillator and pacemaker whose proper functioning has been verified must be kept at hand.

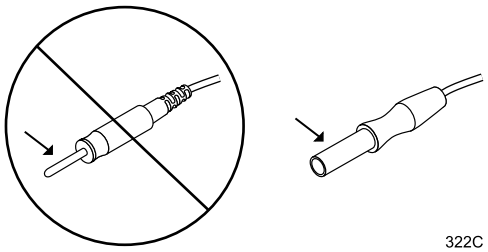
WARNINGS

LEAKAGE CURRENT TEST — When interfacing with other equipment, a test for leakage current must be performed by qualified biomedical engineering personnel before using with patients.

POWER SUPPLY — The device must be connected to a properly installed power outlet with protective earth contacts only. If the installation does not provide for a protective earth conductor, disconnect the monitor from the power line and operate it on battery power, if possible.

All devices of a system must be connected to the same power supply circuit. Devices which are not connected to the same circuit must be electrically isolated when operated (electrically isolated RS232 interface).

PROTECTED LEADWIRES — Only use protected leadwires and patient cables with this monitor. The use of unprotected leadwires and patient cables creates the potential for making an electrical connection to ground or to a high voltage power source which can cause serious injury or death to the patient.



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RATE METERS — Keep pacemaker patients under close observation. Rate meters may continue to count the pacemaker rate during cardiac arrest and some arrhythmias. Therefore, do not rely entirely on rate meter alarms.

WARNINGS

SITE REQUIREMENTS — For safety reasons, all connectors for patient cables and sensor leads are designed to prevent inadvertent disconnection, should someone pull on them. Do not route cables in a way that they may present a stumbling hazard. For devices installed above the patient, adequate precautions must be taken to prevent them from dropping on the patient.

Cautions

CAUTIONS

ACCESSORIES (SUPPLIES) — To ensure patient safety, use only parts and accessories manufactured or recommended by GE Medical Systems *Information Technologies*.

Parts and accessories used must meet the requirements of the applicable IEC 60601 series safety standards and essential performance standards, and/or the system configuration must meet the requirements of the IEC 60601-1-1 medical electrical systems standard.

ACCESSORIES (EQUIPMENT) — The use of ACCESSORY equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

- use of the accessory in the PATIENT VICINITY; and
- evidence that the safety certification of the ACCESSORY has been performed in accordance to the appropriate IEC 60601-1 and/or IEC 60601-1-1 harmonized national standard.

BATTERY POWER — If a device equipped with an optional battery pack will not be used or not be connected to the power line for a period of over six months, remove the battery.

CAUTIONS

BEFORE INSTALLATION — Compatibility is critical to safe and effective use of this device. Please contact your local sales or service representative prior to installation to verify equipment compatibility.

DEFIBRILLATOR PRECAUTIONS — Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires.

Proper placement of defibrillator paddles in relation to the electrodes is required to ensure successful defibrillation.

DISPOSABLES — Disposable devices are intended for single use only. They should not be reused as performance could degrade or contamination could occur.

DISPOSAL — At the end of its service life, the product described in this manual, as well as its accessories, must be disposed of in compliance with the guidelines regulating the disposal of such products. If you have questions concerning disposal of the product, please contact GE Medical Systems *Information Technologies* or its representatives.

ELECTROCAUTERY PRECAUTIONS — To prevent unwanted skin burns, apply electrocautery electrodes as far as possible from all other electrodes, a distance of at least 15 cm/6 in. is recommended.

EMC — Magnetic and electrical fields are capable of interfering with the proper performance of the device. For this reason make sure that all external devices operated in the vicinity of the monitor comply with the relevant EMC requirements. X-ray equipment or MRI devices are a possible source of interference as they may emit higher levels of electromagnetic radiation.

CAUTIONS

INSTRUCTIONS FOR USE — For continued safe use of this equipment, it is necessary that the listed instructions are followed. However, instructions listed in this manual in no way supersede established medical practices concerning patient care.

LOSS OF DATA — Should the monitor at any time temporarily lose patient data, the potential exists that active monitoring is not being done. Close patient observation or alternate monitoring devices should be used until monitor function is restored.

If the monitor does not automatically resume operation within 60 seconds, power cycle the monitor using the power on/off switch. Once monitoring is restored, you should verify correct monitoring state and alarm function.

MAINTENANCE — Regular preventive maintenance should be carried out annually. You are responsible for any requirements specific to your country.

MPSO — The use of a multiple portable socket outlet (MPSO) for a system will result in an enclosure leakage current equal to the sum of all individual earth leakage currents of the system if there is an interruption of the MPSO protective earth conductor. Do not use an additional extension cable with the MPSO as it will increase the chance of the single protective earth conductor interruption.

NEGLIGENCE — GE Medical Systems *Information Technologies* does not assume responsibility for damage to the equipment caused by improperly vented cabinets, improper or faulty power, or insufficient wall strength to support equipment mounted on such walls.

OPERATOR — Medical technical equipment such as this monitor/monitoring system must only be used by persons who have received adequate training in the use of such equipment and who are capable of applying it properly.

CAUTIONS

POWER REQUIREMENTS — Before connecting the device to the power line, check that the voltage and frequency ratings of the power line are the same as those indicated on the unit's label. If this is not the case, do not connect the system to the power line until you adjust the unit to match the power source.

In U.S.A., if the installation of this equipment will use 240V rather than 120V, the source must be a center-tapped, 240V, single-phase circuit.

RESTRICTED SALE — U.S. federal law restricts this device to sale by or on the order of a physician.

SUPERVISED USE — This equipment is intended for use under the direct supervision of a licensed health care practitioner.

UNINTENTIONAL RADIO FREQUENCY (RF) INTERFERENCE — Unintentional RF interference could degrade the reliability and performance of the wireless data link. The facility must maintain an RF environment free from unintentional interference. Refer to the service manual for more information.

VENTILATION REQUIREMENTS — Set up the device in a location which affords sufficient ventilation. The ventilation openings of the device must not be obstructed. The ambient conditions specified in the technical specifications must be ensured at all times.

Notes

- Put the monitor in a location where you can easily see the screen and access the operating controls.
- This product is not likely to cause abnormal operation of other patient-connected equipment such as cardiac pacemaker or other electrical stimulators. Exceptions are noted in the pacemaker monitoring section, if applicable.
- This product is protected against the effects of cardiac defibrillator discharges to ensure proper recovery, as required by test standards. (The screen may blank during a defibrillator discharge but recovers within seconds as required by test standards.)

Reference Literature

Medical Device Directive 93/42/EEC

EN 60601-1/1990 + A1: 1993 + A2: 1995: Medical electrical equipment. General requirements for safety

EN 60601-1-1/9.1994 + A1 12.95: General requirements for safety. Requirements for the safety of medical electrical systems.

IEC Publication 513/1994: Fundamental aspects of safety standards for medical equipment.

ROY, O.Z.: Summary of cardiac fibrillation thresholds for 60-Hz currents and voltages applied directly to the heart. Med. & Biol. Engn. & Computing 18: 657...659 (1980).

Classification

Equipment components are classified, according to IEC 60601-1, as:

	Type of protection against electrical shock	Degree of protection against electrical shock	Degree of protection against harmful ingress of water	Degree of safety of application in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide	Method(s) of sterilization or disinfection recommended by the manufacturer	Mode of operation
Solar 8000M CPU	I	Not Marked	Ordinary	Not Suitable	NA	Continuous
Tram modules: ECG, BP, Temp, CO NBP, SPO2	 NA NA	 CF BF	 Ordinary Ordinary	 Not Suitable Not Suitable	 NA NA	 Continuous Continuous
Solar ECG/Resp module	NA	CF	Ordinary	Not Suitable	NA	Continuous
BP module	NA	CF	Ordinary	Not Suitable	NA	Continuous
Dual BP module	NA	CF	Ordinary	Not Suitable	NA	Continuous
BP/dual temp module	NA	CF	Ordinary	Not Suitable	NA	Continuous
NBP module	NA	BF	Ordinary	Not Suitable	NA	Continuous
Solar SPO2 module	NA	BF	Ordinary	Not Suitable	NA	Continuous
Solar SPO2 module with Masimo SET	NA	BF	Ordinary	Not Suitable	NA	Continuous
Dual temp module	NA	CF	Ordinary	Not Suitable	NA	Continuous
SvO2 module	NA	B	Ordinary	Not Suitable	NA	Continuous
RM module	NA	CF	Ordinary	Not Suitable	NA	Continuous
TC module	NA	CF	Ordinary	Not Suitable	NA	Continous
Mainstream CO2 module Sidestream CO2 module	NA	B BF	Ordinary	Not Suitable	NA	Continuous
Solar BP/CO module	NA	CF	Ordinary	Not Suitable	NA	Continuous
ICG module	NA	BF	Ordinary	Not Suitable	NA	Continuous
BIS/EEG module	NA	B	Ordinary	Not Suitable	NA	Continuous
Tram-net interface adapter	NA	Not Marked	Ordinary	Not Suitable	NA	Continuous
Octanet Connectivity Device	I	Not Marked	Ordinary	Not Suitable	NA	Continuous
Tram-rac without power supply	NA	Not Marked	Ordinary	Not Suitable	NA	Continuous
Tram-rac with power supply	I	Not Marked	Ordinary	Not Suitable	NA	Continuous
PRN 50 and PRN 50-M Writers	I	Not Marked	Ordinary	Not Suitable	NA	Continuous
Keypad	NA	Not Marked	Ordinary	Not Suitable	NA	Continuous
Remote control	NA	Not Marked	Ordinary	Not Suitable	NA	Continuous

I: Class I equipment
B: Type B applied part
BF: Type BF applied part
CF: Type CF applied part
NA: Not applicable
Ordinary: Ordinary equipment (enclosed equipment without protection against ingress of water)
Not Suitable: Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide

Underwriters Laboratories, Inc.

Classified by Underwriters Laboratories Inc. with respect to electric shock, fire, mechanical and other specified hazards, only in accordance with UL 2601-1, CAN/CSA C22.2 No. 601.1, IEC 60601-1, and, if required, IEC 60601-2-26, IEC 60601-2-27, IEC 60601-2-30, IEC 60601-2-34, IEC 60601-1-1.

Equipment Symbols

NOTE

Some symbols may not appear on all equipment.

ATTENTION: Consult accompanying documents.

CAUTION: To reduce the risk of electric shock, do NOT remove cover. Refer servicing to qualified service personnel.

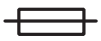
NOTE

The rating of protection against electric shock (indicated by symbol for CF or BF) is achieved only when used with patient applied parts recommended by GE Medical Systems *Information Technologies*.

TYPE CF APPLIED PART: Isolated (floating) applied part suitable for intentional external and internal application to the patient including direct cardiac application. “Paddles” outside the box indicate the applied part is defibrillator proof.
[Medical Standard Definition:] F-type applied part (floating/isolated) complying with the specified requirements of IEC 60601-1/UL 2601-1/CSA 601.1 Medical Standards to provide a higher degree of protection against electric shock than that provided by type BF applied parts.

TYPE BF APPLIED PART: Isolated (floating) applied part suitable for intentional external and internal application to the patient excluding direct cardiac application. “Paddles” outside the box indicate the applied part is defibrillator proof.
[Medical Standard Definition:] F-type applied part (floating/isolated) complying with the specified requirements of IEC 60601-1/UL 2601-1/CSA 601.1 Medical Standards to provide a higher degree of protection against electric shock than that provided by type B applied parts.

TYPE B APPLIED PART: Non-isolated applied part suitable for intentional external and internal application to the patient excluding direct cardiac application.
[Medical Standard Definition:] Applied part complying with the specified requirements of IEC 60601-1/UL 2601-1/CSA 601.1 Medical Standards to provide protection against electric shock, particularly regarding allowable leakage current.



Fuse

Equipotential

Alternating current (AC)

Power; I = ON; O = OFF

For your notes

4 Maintenance

For your notes

Biocompatibility

When used as intended, the parts of the product described in this operator manual, including accessories that come in contact with the patient during the intended use, fulfill the biocompatibility requirements of the applicable standards. If you have questions about this matter, please contact GE Medical Systems *Information Technologies* or its representatives.

Inspection

An effective maintenance schedule should be established for your monitoring equipment and reusable supplies. This should include inspection as well as general cleaning on a regular basis. The maintenance schedule must comply with the policies of your institution's infection control unit and/or biomedical department.

WARNING
Failure on the part of the responsible hospital or institution employing the use of this monitoring equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards.

Check with your biomedical department to be sure preventive maintenance and calibration has been done. The service manuals contain detailed information.

Follow these guidelines when inspecting the equipment:

- Inspect the equipment for obvious physical damage and replace damaged items.
- Inspect all cords for fraying or other damage. Inspect all plugs and connectors for bent prongs or pins. Repair or replacement must be performed by qualified service personnel.
- Inspect all cable insulation. Qualified service personnel should repair or replace damaged or deteriorated cables.

In the United States, GE Medical Systems *Information Technologies* Service is available 24 hours a day by calling 800-558-7044.

Outside the United States, please contact your sales/service office.

NOTE
Refer to the service manuals for more comprehensive checkout procedures.

General Cleaning

WARNING
Disconnect the monitor from the power line before cleaning or disinfecting its surface.

The equipment should be cleaned on a regular basis. (Comply with the policies of your institution's infection control unit and/or biomedical department.) The exterior surfaces of the equipment may be cleaned with a dampened, lint-free cloth. Use one of the following approved solutions:

- ammonia (diluted),
- Cidex,
- sodium hypochlorite bleach (diluted), or
- mild soap (diluted).

To avoid damage to the equipment, follow these rules:

CAUTION
Failure to follow these rules may melt, distort, or dull the finish of the case, blur lettering on the labels, or cause equipment failures.

- Always dilute the solutions according to the manufacturer's suggestions.
- Always wipe off all the cleaning solution with a dry cloth after cleaning.
- Never use a cleaning substance containing wax.
- Never pour or spray water or any cleaning solution on the equipment.
- Never permit fluids to run behind switches, into the connectors, or into any ventilation openings in the equipment.
- Never use these cleaning agents:
  - abrasive cleaners or solvents of any kind,
  - acetone,
  - ketone,
  - alcohol-based cleaning agents, or
  - Betadine

To clean the display screen, use a soft, clean cloth dampened with a glass cleaner. Never spray the glass cleaner directly onto the display, and never use alcohol or hospital disinfectants like Cidex or Betadine.

Cleaning the Touchscreen

NOTE

Turn the display power off before cleaning the touchscreen.

Clean the touchscreen with one of the following approved solutions:

- Household glass cleaner
- Virex (full strength)
- Cavicide (diluted: 1/2 oz per gallon of water)

To avoid damage to the equipment, follow these rules:

CAUTION

Failure to follow these rules may melt, distort, or dull the finish of the case, blur lettering on the labels, or cause equipment failures.

- Always dampen the towel and then clean the touchscreen.
- Do NOT spray cleaner directly on the touchscreen.
- Do NOT use these chemicals on the touchscreen:
  - Acetone
  - Methylene chloride
  - Methyl ethyl ketone
  - Hexane
  - Ammonia-based glass cleaners

Cleaning Applied Parts

Cables and Leadwires

CAUTION
Do not use acetone or ketone solvents for cleaning; do not use an autoclave or steam cleaner.

Cables and leadwires can be cleaned with a warm, damp cloth and mild soap, or isopropyl alcohol wipes. Refer to the previous page for safe cleaning techniques.

For more intensive disinfecting (near sterile) Ethylene Oxide (ETO) is acceptable but will reduce the useful lifetime of the cable or leadwire.

CAUTION
The decision to sterilize must be made per your institution's requirements with an awareness of the effect on the integrity of the cable or leadwire.

Other

For other applied parts such as temperature sensors, catheters, pulse oximetry probes, etc., you must consult the manufacturer for cleaning, sterilization, or disinfecting methods.

Internal Lithium Battery

The Solar 8000M processing unit contains a lithium battery. This battery is used to retain factory default settings when AC power to the monitor is turned off.

If the lithium battery charge becomes low during normal operation, the following message appears near the middle of the screen:

SERVICE MONITOR
BATTERY ERROR

Contact service if this message appears (refer to "How to Reach Us" at the front of this manual).

If the lithium battery fails when AC power to the monitor is turned off, the following message will appear on the display when the monitor is turned on again:

ERROR: THE INTERNAL BATTERY THAT MAINTAINS
THE MONITOR'S DEFAULTS HAS FAILED!
*** SERVICE MAY BE REQUIRED ***

The monitor cannot be used until the lithium battery is replaced. Contact service if this message appears (refer to "How to Reach Us" at the front of this manual).

Technical Maintenance

Schematic diagrams, specifications, and other relevant technical information can be found in the service manuals supplied with this equipment. Comply with the policies of your institution's biomedical department, or the recommendations made within the Preventive Maintenance section of the product's service manual.

CAUTION
If the monitor displays the message "*PREVENTIVE MAINTENANCE REQUIRED,*" contact your biomedical department immediately to perform the yearly preventive maintenance as described in the service manual.

Technical Specifications

Technical specifications are located in the service manual.

For your notes

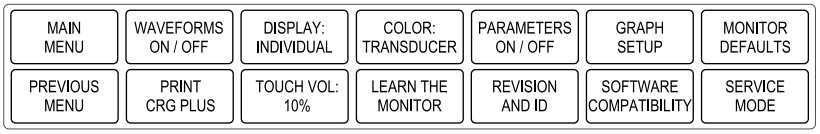
5 Monitor Setup

For your notes

Monitor Setup Menu

The Monitor Setup menu lets you customize the monitor to best suit your unit's and patients' needs. In some cases these changes can be saved as monitor defaults, which are recalled each time you admit a patient.

To access the monitor setup menu, select *MORE MENUS* from the main display, then select *MONITOR SETUP*.



Monitor Setup Menu

- *WAVEFORMS ON/OFF* — Reassigns waveform positions on the display or turn certain waveforms off.
- *DISPLAY* — Chooses a display mode, which puts pressure waveforms on an individual or full (common) scale.
- *COLOR* — Chooses a color configuration.
- *PARAMETERS ON/OFF* — Clears unneeded parameter windows from the display and turn them back on again when needed.
- *GRAPH SETUP* — Selects waveforms to be graphed, graph speed, and graph location. CRG Plus graph options are included in this menu.
- *MONITOR DEFAULTS* — Configures alarms, set alarm limits, and establish monitor display defaults.
- *PRINT CRG PLUS* — Prints CRG Plus waveforms as selected in the Graph Setup menu.
- *TOUCH VOL* — Adjusts the volume of the tone that sounds when the touchscreen is touched.
- *LEARN THE MONITOR* — Displays information windows containing basic operating instructions.
- *REVISION AND ID* — Displays a list of the software versions currently installed for the various components of the monitor.
- *SOFTWARE COMPATIBILITY* — Displays a software compatibility list.
- *SERVICE MODE* — Used by qualified service personnel to access the service mode.

Detailed information on each option is found in this chapter.

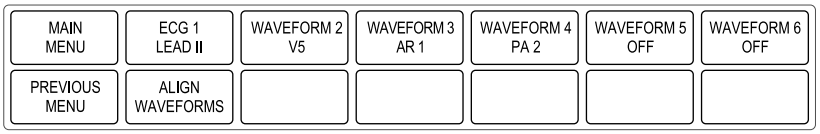
Waveforms On/Off

The Waveforms On/Off menu option allows you to reassign waveforms on the display or turn an individual waveform off.

To access the Waveforms On/Off menu, select *WAVEFORMS ON/OFF* from the Monitor Setup menu. Your display mode (Individual, Full, CRG Plus) determines the menu options available. Refer to the Display section in this chapter for display mode details.

Individual Display Mode

If you are using the individual display mode, the Waveforms On/Off menu looks like this:



Waveforms On/Off Menu — Individual Mode

To change a displayed waveform, select a *WAVEFORM* menu option to display a popup menu. In the popup menu, move the pointer to the waveform you want to display, then select it. Choose *OFF* if you do not want a waveform displayed in that position.

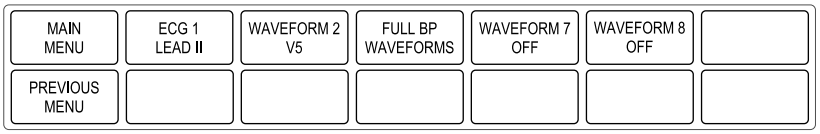
Align Waveforms

When monitoring in the individual display mode, waveforms automatically align with their respective parameter windows. You can override alignment with the waveforms on/off menu.

Use the *ALIGN WAVEFORMS* option in this menu to automatically realign waveforms with their parameter windows.

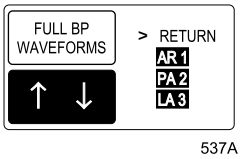
Full Display Mode

If you are using the full display mode, the Waveforms On/Off menu looks like this:



Waveforms On/Off Menu — Full Mode

The *FULL BP WAVEFORMS* menu option allows you to select the pressure waveforms you want to display on the full scale.



Full BP Waveforms Popup Menu

The pressures displayed in the popup menu are determined by the pressures being monitored. The pressure waveforms that are currently on the full scale are highlighted. Only four pressure waveforms can be displayed on the full scale at one time.

Use the Trim Knob control or touchscreen to select or deselect pressure waveforms.

There are left and right scales. To position a waveform on a right or left scale, use the Scales menu option in the individual pressure menu.

CRG Plus Display Mode

If you are using one of the CRG Plus display modes, the Full BP Waveforms menu option reads *CRG PLUS WAVEFORMS*. Use the popup menu as described above. Refer to Chapter 9, CRG Plus Display, for more information.

Display

The Display menu option controls the display mode for monitored pressure parameters. The Display popup menu offers the choices described below.

NOTE

Display mode can be set as a monitor default. Refer to the Monitor Defaults section in this chapter.

- *INDIVIDUAL* — A maximum of six waveforms, each on an independent scale, can be displayed. Waveforms automatically align with their respective parameter windows.
- *FULL* — A maximum of eight waveforms can be displayed. The waveforms in the first two positions are on individual scales. Then, up to four pressures waveforms are displayed on a full (common) scale. The last two waveforms, if any, are displayed on individual scales.
- *FULL GRID* — The full display mode, with additional graticules displayed on the screen. The additional graticules do not print when waveforms are graphed.

NOTE

When using the full or full grid modes, there are left and right scales. Read ART, FEM, UAC, and SP pressures using the left scale markers. Read PA, CVP, RA, UVC, LA, and ICP pressures using the right scale markers. Use the Scales menu option in the individual parameter menu to change pressures from one side to the other.

- *CRG FULL* — A full scale mode with left and right scales.
- *CRG INDV* — Individual scales for each parameter.

NOTE

Refer to Chapter 9, CRG Plus Display, for details on the CRG Plus full and individual display modes.

- *EEG SPECTRA* — Displays two- or four-channel EEG spectra, depending on the number of channels being monitored and the selection made in the EEG Spectra popup menu.
- *BIS SPECTRA* — Displays either a single CSA spectrum or a single DSA spectrum, depending on the selection made in the BIS Spectra Setup menu.

NOTE

Refer to the Patient Monitoring System Operator's Manual Supplement for the BIS/EEG Module for details on BIS and EEG spectral displays.

Color

Selecting the *COLOR* menu option opens a popup menu to select a color format. The tables below indicate the parameter colors used in each color format.

***CLINICAL* Color Format**	
Parameter(s)	**Color**
ECG	Amber
Hemodynamics	Green
Cardiopulmonary	Blue
Temperature	Blue
Gas	White
Alarms	Red
All other parameters	Blue

***TRANSDUCER* Color Format**	
Parameter(s)	**Color**
ECG	Green
Priority ART1/FEM1/UAC1	Red
Additional ART/FEM/UAC	White
PA	Yellow
CVP/RA/UVC	Blue
LA/ICP	White
SP	Green
POC	Red
Alarms	Red
All other parameters	Green

***CRG PLUS* Color Format**	
Parameter(s)	**Color**
ECG	Green
Priority ART1/FEM1/UAC1	Red
MAP	Red
All other pressures	White
CO2/RR	Yellow
SPO2	Blue
Alarms	Red
Waveforms not part of the CRG Plus display	Shown in Transducer color format

NOTE

With the Transducer and CRG Plus color formats, the pressure colors are based on the priority set up in monitor defaults. The arterial line (ART, FEM, or UAC) set at the highest priority is red, and all other pressures are white.

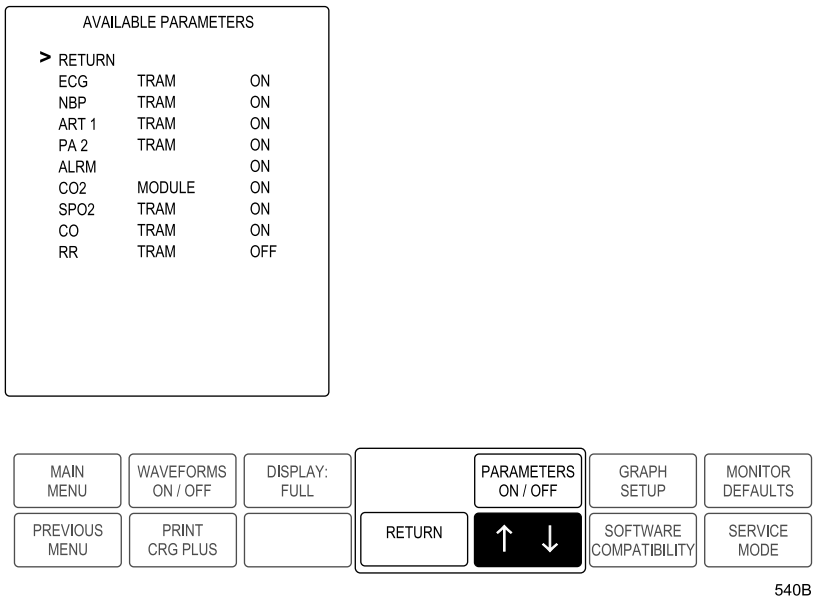
Parameters On/Off

This menu option allows you to turn specific parameters on and off. Turning a parameter off removes the waveform and the parameter window from the display. Alarms are off and data is not collected in vital signs for that parameter.

NOTE

ECG cannot be turned off.

When the Parameters On/Off menu option is selected, an information window opens. The first column in the information window shows the parameter name, the second indicates the data source, and the third column indicates whether the parameter is on or off.

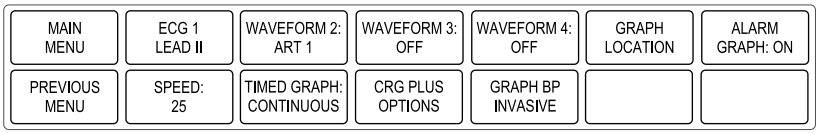


Parameters On/Off Information Window

If a parameter is on, selecting it turns it off, and vice versa. The change takes effect immediately. The information window remains open so you can select another parameter if desired. To close the information window and popup menu, select *RETURN*.

Graph Setup

Selecting the Graph Setup menu option opens a new menu from which you can change certain graphing features.



Graph Setup Menu

- *ECG 1* — Designates the ECG lead graphed in position 1.
- *WAVEFORM 2 (3, 4)* — Designates the other waveforms to be graphed.
- *GRAPH LOCATION* — Displays a new menu to select print locations for manual and alarm graphs.
- *ALARM GRAPH* — Turns automatic alarm graphing on and off.
- *SPEED* — Controls the speed at which a graph is run.
- *TIMED GRAPH* — Controls the duration of a manual graph.
- *CRG PLUS OPTIONS* — Used to select CRG Plus waveforms to graph, and to turn automatic graphing on and off.
- *GRAPH BP INVASIVE* — Used to select and graph invasive BP waveforms.

ECG 1, Waveform 2, Waveform 3, Waveform 4

Each of these menu options designates a waveform to be printed on the graph strip. The system prioritizes the waveforms based on the set system priority defaults.

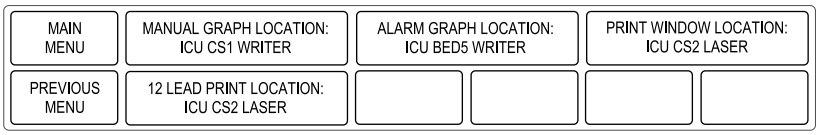
NOTE

Although pressures may be displayed on a full scale, they are graphed on individual scales. You can verify the individual scales by switching to the individual display mode.

Selecting any of these options from the Graph Setup menu opens a popup menu. For ECG 1, the popup menu lists all leads currently being monitored. The Waveform popup menus list all leads and parameters currently being monitored. Select the parameter you wish to appear on the graph, then close the popup menu.

Graph Location

The Graph Location menu option displays a menu that allows you to choose writers for alarm and manual graphs.


MAIN MENU
MANUAL GRAPH LOCATION: ICU CS1 WRITER
ALARM GRAPH LOCATION: ICU BED5 WRITER
PRINT WINDOW LOCATION: ICU CS2 LASER
PREVIOUS MENU
12 LEAD PRINT LOCATION: ICU CS2 LASER
543A

Graph Location Menu

- *MANUAL GRAPH LOCATION* — Designates to which printer a graph strip with patient waveforms is printed. Manual graphs are started and stopped using the **Graph Go/Stop** button on the keypad or remote control.
- *ALARM GRAPH LOCATION* — Designates to which printer an alarm graph strip with patient waveforms is printed. Alarm graphs start automatically when a crisis or warning alarm occurs.
- *PRINT WINDOW LOCATION* — Designates to which printer the data from an information window is printed. Other data always sent to this location includes:
  - CRG Plus
  - ST
  - All ECG
  - Alarm histories (ST history data only prints to a laser printer.)
  - PA wedge
  - Cardiac output waveforms
  - PAW volume and flow volume loops

- *12 LEAD PRINT LOCATION* — Designates to which laser printer a 12 SL analysis with patient waveforms is printed. Laser printers are the only valid selections for this option. If a laser printer does not exist on the network, a location defined in the print window location is used.

When you select one of the graph location options, a popup menu and information window open. The information window contains a list of printers available on your network.

The first column in the information window indicates the unit where the printer is located. Only those printers with the same unit name as the monitor are displayed. The second column indicates the bed number or central station number to which the printer is connected. The third column indicates the type of printer. *WRITER* is a digital writer, *LASER* is a laser printer.

Select the printer you wish to designate, then select *RETURN* to close the information window and popup menu. The name of the printer you selected is displayed in the menu option.

NOTE

Graph locations cannot be set as monitor defaults. However, upon discharge, graph location designations remain as last selected.

If the selected printer is not available, these menu options continue to show that printer even though it is not available. You must change it to an available device. The message "*SAVING*" is displayed when attempting to graph to an unavailable device.

Alarm Graph

This menu option turns automatic alarm graphs off and on. This is a direct action menu option. Selecting it switches back and forth between off and on.

An arrhythmia alarm graph continues to run until a normal sinus rhythm is detected, or until you manually stop it at the printer. All other alarm graphs run for 20 seconds.

NOTE

To convert an arrhythmia alarm graph to a manual graph, you must stop the graph using the Graph Stop key on the writer, then immediately restart the graph.

Speed

This menu option controls the speed at which a graph is printed. The slower the speed, the more condensed the data is. This option affects manual graphs only. It must be selected before starting the graph.

NOTE
Alarm graphs always run at 25 millimeters per second.

Selecting the speed menu option opens a popup menu. Choices are 0.1, 0.5, 1, 5, 10, 12.5, 25, and 50 millimeters per second.

NOTE
Laser printers do not support the 0.1 millimeter per second speed.

Timed Graph

This menu option controls the duration for which a manual graph is printed. Selecting the Timed Graph menu option opens a popup menu. Choices are *10 SEC, 20 SEC, 30 SEC, 60 SEC,* or *CONTINUOUS*.

CRG Plus Options

This menu option lets you choose up to three CRG Plus parameters to be graphed at the print window location. You can also choose to have an automatic CRG Plus graph run every two minutes, or to run a CRG Plus graph on alarm. Refer to Chapter 9, CRG Plus Display, for details.

Graph BP Invasive

This menu option opens a popup menu that allows you to select currently monitored blood pressure waveforms for graphing. When this option is activated, blood pressure waveforms are the only parameters that can be graphed. Waveforms are graphed on one scale using the full grid space.

You cannot change a Graph BP Invasive selection while a graph run is in progress. The graph will stop when you press the **Graph Go/Stop** button on the keypad or remote control, or when the selected graph period expires. If another type of graph is currently active, the Graph BP Invasive selection is disregarded.

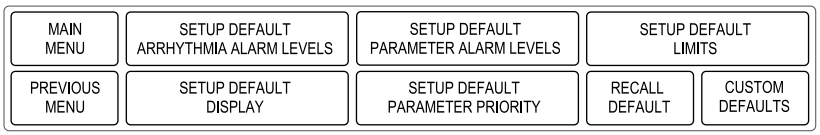
Monitor Defaults

Alarm levels, alarm limits, and many other monitor settings can be set up as monitor defaults. Multiple monitor defaults can be set and recalled while monitoring an admitted patient. There is a monitor defaults worksheet in Chapter 21, Appendices. You can use this worksheet to record your default settings.

If the monitor mode is changed (e.g., Adult-ICU to Neonatal-ICU), any monitor defaults you have set up revert to the factory default settings. However, the monitor mode is usually established at the time of monitor installation, and can only be changed in the Service menu.

CAUTION
If you disconnect a parameter cable at any point along the cable or disconnect it from the module, and the parameter window is removed from the monitor display, all alarm limits may revert to the set monitor default alarm limits when the cable is reconnected.

NOTE
Monitor defaults can only be changed when the monitor is in a discharged state. Any changes made are effective immediately, but a patient must be admitted to the monitor for fully functional alarms.



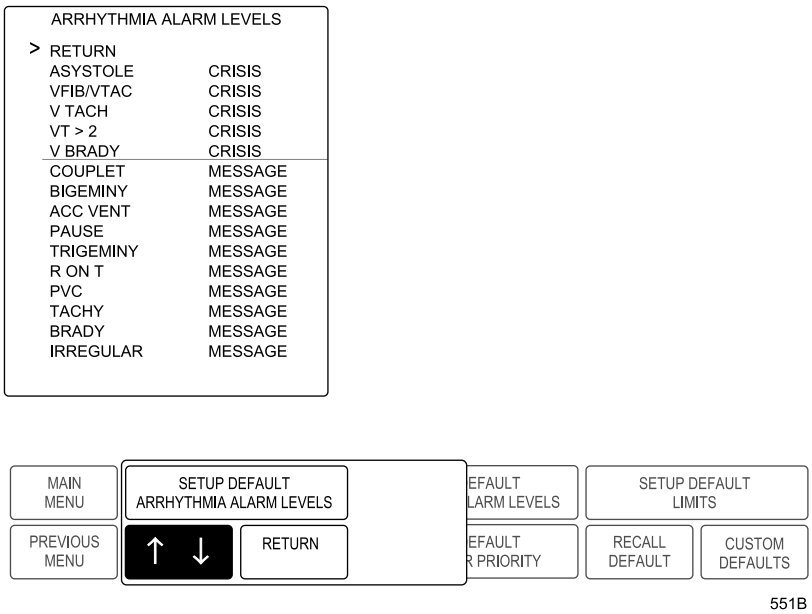
Monitor Defaults Menu

- *SETUP DEFAULT ARRHYTHMIA ALARM LEVELS* — Adjusts arrhythmia alarms to other alarm levels.
- *SETUP DEFAULT PARAMETER ALARM LEVELS* — Adjusts parameter alarms to other alarm levels.
- *SETUP DEFAULT LIMITS* — Sets alarm limits for all parameters.
- *SETUP DEFAULT DISPLAY* — Determines display settings, such as waveforms graphed, etc.
- *SETUP DEFAULT PARAMETER PRIORITY* — Determines the priorities for display of parameters.
- *RECALL DEFAULT* — Recalls monitor defaults without performing a discharge procedure.
- *CUSTOM DEFAULTS* — Allows you to modify multiple monitor defaults.

Setup Default Arrhythmia Alarm Levels

Arrhythmia calls are each assigned to one of the four patient status alarm levels. The Setup Default Arrhythmia Alarm Levels option allows you to view the levels assigned, and change them if desired.

Selecting the Setup Default Arrhythmia Alarm Levels menu option opens a popup menu and an information window. The information window displays a list of the arrhythmia calls and their corresponding alarm levels.



Setup Default Arrhythmia Alarm Levels Popup Menu and Information Window

Refer to the Selecting Options from Scroll Lists section in Chapter 1, The Basics, for the procedure to change the alarm levels.

NOTE

In the Basic software package, only Asystole, VFIB/VTAC, and V Tach appear. Only V Tach can be moved to another level. All other arrhythmia calls appear and are adjustable in the Cardiac software package.

NOTE

Asystole and VFIB/VTAC can only be moved to another level when in Operating Room mode.

Setup Default Parameter Alarm Levels

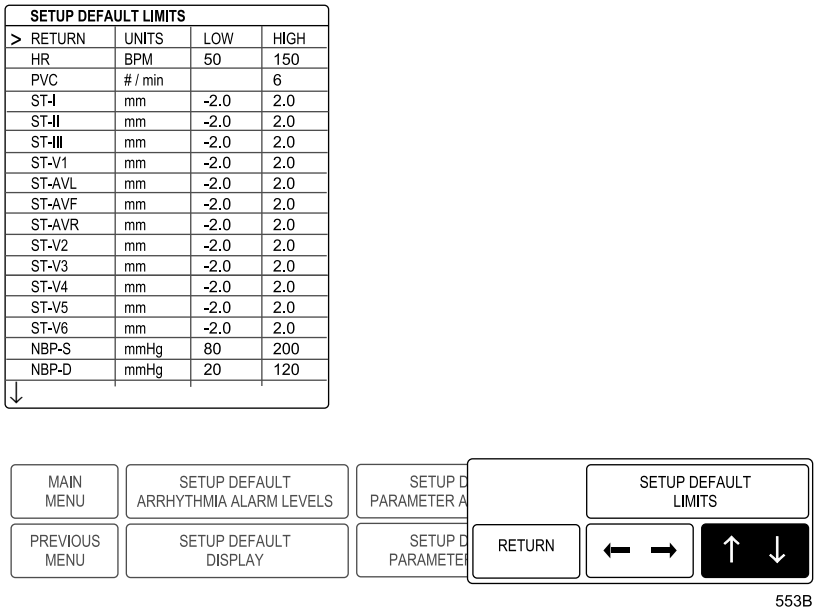
You can set default alarm levels for most parameters supported by the monitor. The POC alarm level cannot be changed from the message level.

Use the Setup Default Parameter Alarm Levels menu option to view and adjust default alarm levels for parameters. All parameters that can be monitored are listed in the information window. Refer to the Selecting Options from Scroll Lists section in Chapter 1, The Basics, for the procedure to change the alarm levels.

Setup Default Limits

You can set default limits for all parameters.

1. Select *SETUP DEFAULT LIMITS* from the Monitor Defaults menu. A popup menu and information window are displayed.


SETUP DEFAULT LIMITS
> RETURN | UNITS | LOW | HIGH
HR | BPM | 50 | 150
PVC | # / min | | 6
ST-I | mm | -2.0 | 2.0
ST-II | mm | -2.0 | 2.0
ST-III | mm | -2.0 | 2.0
ST-V1 | mm | -2.0 | 2.0
ST-AVL | mm | -2.0 | 2.0
ST-AVF | mm | -2.0 | 2.0
ST-AVR | mm | -2.0 | 2.0
ST-V2 | mm | -2.0 | 2.0
ST-V3 | mm | -2.0 | 2.0
ST-V4 | mm | -2.0 | 2.0
ST-V5 | mm | -2.0 | 2.0
ST-V6 | mm | -2.0 | 2.0
NBP-S | mmHg | 80 | 200
NBP-D | mmHg | 20 | 120
MAIN MENU
SETUP DEFAULT ARRHYTHMIA ALARM LEVELS
SETUP D PARAMETER A
SETUP DEFAULT LIMITS
PREVIOUS MENU
SETUP DEFAULT DISPLAY
SETUP D PARAMETE
RETURN
553B

Setup Default Limits Popup Menu and Information Window

2. Select the parameter for which you want to change the default limits.
3. Highlight your choice of the low or high limit.
4. Press the Trim Knob control, then rotate it (or use the touchscreen arrows) to change the value of the the high or low limit.
5. Highlight the parameter, then press the Trim Knob control to deselect the parameter.

   NOTE

   This step is not necessary when using the touchscreen.

6. Select *RETURN* when all changes are completed. The popup menu and information window close.

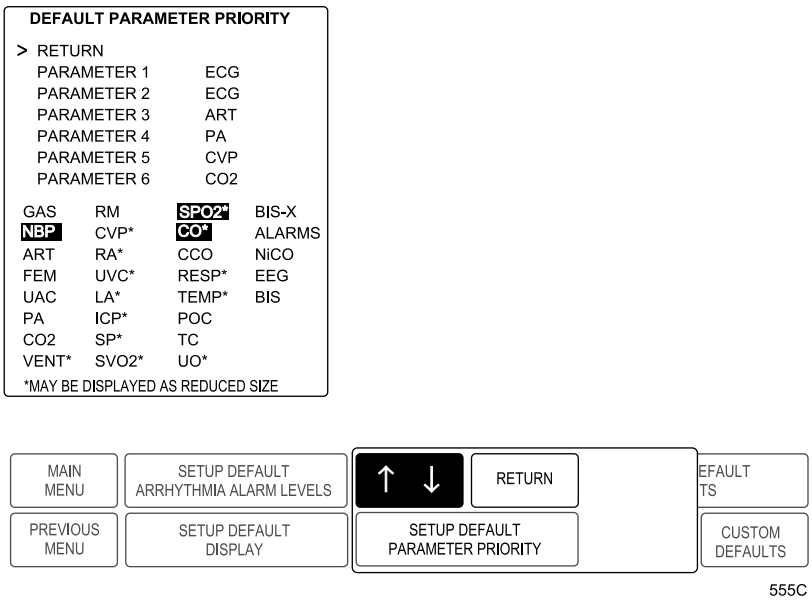
Setup Default Display

This menu option allows you to set up certain aspects of the display as defaults. When *SETUP DEFAULT DISPLAY* is selected, a popup menu and information window open. The display items listed in the information window are determined by the software package(s) installed on the monitor. Select and change the desired item(s), then select *RETURN* to close the information window and popup menu.

Setup Default Parameter Priority

This menu option allows you to select how the parameter windows are prioritized on the display.

1. Select *SETUP DEFAULT PARAMETER PRIORITY* from the Monitor Defaults menu. A popup menu and information window open.



Setup Default Parameter Priority Popup Menu and Information Window

2. Select parameters for the various positions on the display.
3. Select *RETURN* when you have finished. The information window and popup menu close.

The *PARAMETER* selections in the top half of the window are displayed as full-size parameter windows on the right side of the display. You control the order in which they appear when you designate a parameter for each position.

The parameters listed in the lower half of the information window are displayed at the bottom of the screen only when there is no room on the right side. Parameters designated with an asterisk can be displayed at reduced size in order to accommodate up to eleven parameters. The software automatically resizes a parameter window when necessary.

You can control the order in which parameters are displayed by first deselecting the highlighted parameters in the information window, then reselecting them in the order you want them displayed (first selected equals first displayed).

Here are some additional points to remember regarding parameter priorities:

- *PARAMETER 1* cannot be changed. It is always ECG.
- If *PARAMETER 2* is set as ECG or ST, the ECG parameter window is always displayed as a larger size. This window occupies the space of TWO parameter windows.
- If six or fewer parameters are being monitored, the parameter windows occupy the six positions on the right side of the display. These windows are always normal size windows. If more than six parameters are being monitored, some will occupy space at the bottom of the display.
- A maximum of 11 parameters can be displayed when some half-size parameters are chosen. The software does not allow you to pick more parameters than can be displayed.
- If you are not monitoring a designated parameter, the space is filled with the next prioritized parameter. If you begin monitoring the designated parameter, the display reconfigures so the parameter can occupy its designated space.
- Whenever possible, waveforms align with their corresponding parameter window. You can override waveform alignment with the Waveforms On/Off option. They can be realigned with the Align Waveforms option in the Waveforms On/Off menu.

Recall Default

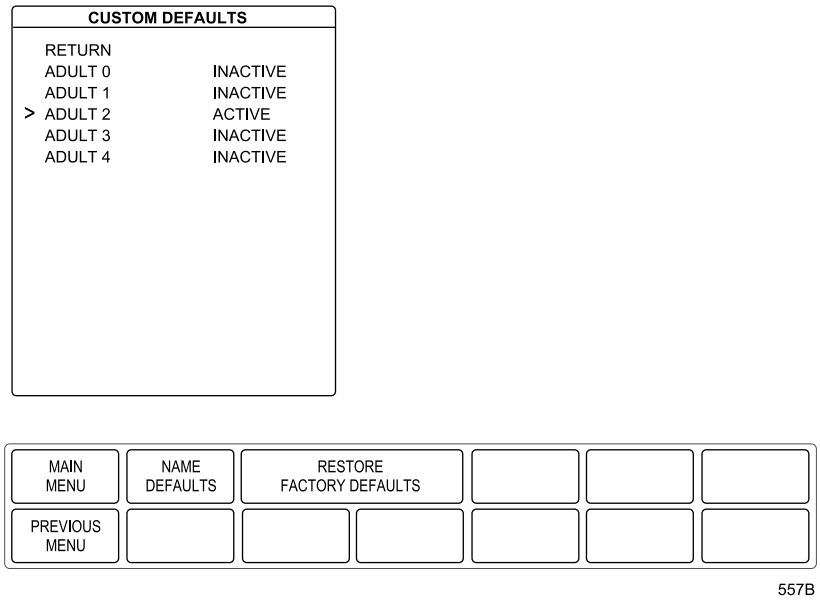
Multiple monitor defaults are a feature of the monitor. This menu option allows you to recall previously named monitor defaults while monitoring an admitted patient. You do not have to discharge the patient when you use the Recall Default option.

Selecting *RECALL DEFAULT* from the Monitor Defaults menu opens a popup menu and an information window, which lists five sets of monitor defaults. Select the desired default set. Select *RETURN* to close the popup menu and information window.

The name of the monitor default you selected appears at the top of the display.

Custom Defaults

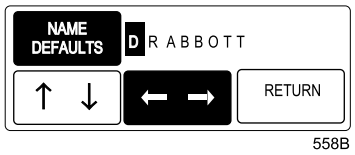
Select *CUSTOM DEFAULTS* from the Monitor Defaults menu to open a menu and information window that allow you to change the name of the monitor default entry or restore factory defaults.



Custom Defaults Menu and Information Window

Name Defaults

1. Select *NAME DEFAULTS* from the Custom Defaults menu. A popup menu is displayed.



Name Defaults Popup Menu

2. Select the default name you wish to change. The selected default name appears in the Name Defaults popup menu.

3. Enter the characters for the name. You can enter up to 12 characters per name. Refer to Chapter 1, The Basics, for help with this procedure.
4. When you have entered the characters you desire, select *RETURN* to return to the Custom Defaults information window.

Restore Factory Defaults

This option allows you to restore the factory default settings.

1. Select the *RESTORE FACTORY DEFAULTS* option from the Custom Defaults menu and position the arrow in front of the default you wish to have overwritten by the factory default.
2. Press the Trim Knob control or touch the *RESTORE FACTORY DEFAULTS* menu option. A popup menu opens, displaying all choices.
3. Select your choice and close the popup menu.

Upon restoration, the custom default name will change to the factory default name. The predefined names for the various monitor defaults are determined by the patient-monitor mode. They are:

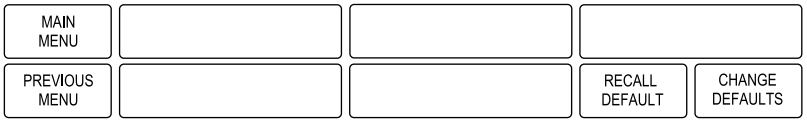
- *NEO 0* through *NEO 4*
- *ADULT 0* through *ADULT 4*
- *OR 0* through *OR 4*

An asterisk (*) indicates that the user has changed the monitor default settings from the original factory default. The asterisk is only displayed when the predefined monitor default name is used (e.g., *NEO 3**).

When a patient is discharged, the monitor default recalled depends on the monitor mode. If the monitor mode is Adult-ICU or Neonatal-ICU, the monitor default recalled is the first entry in the Recall Default information window. If the monitor mode is Operating Room, the monitor default recalled is the currently active monitor default.

Monitor Defaults Password

Monitor defaults password protection can be used to restrict access to the Monitor Defaults menu. When password protection is enabled, selecting *MONITOR DEFAULTS* displays a Monitor Defaults menu with limited options.



Monitor Defaults Menu with Password Protection Enabled

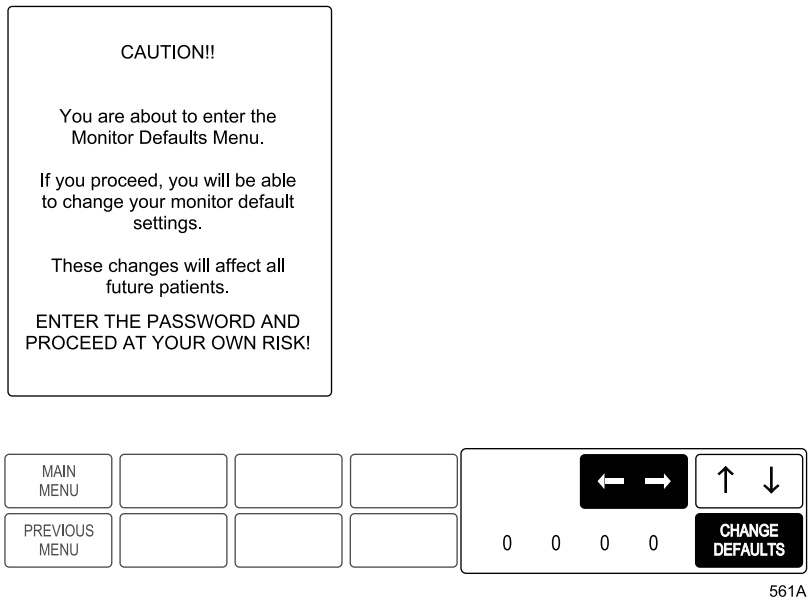
The password protection feature can be enabled or disabled from a menu option in the Service menu. Refer to the Service Mode section in this chapter.

Recall Defaults

This menu option allows you to recall previously named monitor defaults while monitoring an admitted patient. Refer to the Recall Defaults section earlier in this chapter.

Change Defaults

Select the *CHANGE DEFAULTS* option to display a popup menu and information window.


CAUTION!!
You are about to enter the Monitor Defaults Menu.
If you proceed, you will be able to change your monitor default settings.
These changes will affect all future patients.
ENTER THE PASSWORD AND PROCEED AT YOUR OWN RISK!
MAIN MENU
PREVIOUS MENU
0 0 0 0
CHANGE DEFAULTS
561A

Change Defaults Popup Menu and Information Window

When the password is entered, the Monitor Defaults menu is displayed with all options available. Refer to the Monitor Defaults section in this chapter for more information.

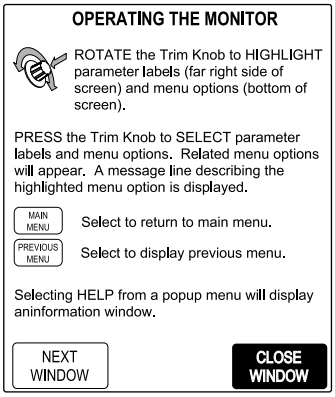
Print CRG Plus

This direct action option prints the CRG Plus waveforms. You can choose which waveforms will print in the Graph Setup menu, CRG Plus options.

The graph is printed at the print window location as designated in the Graph Setup menu, Graph Location. The CRG Plus information does not have to be displayed on the screen to print.

Learn the Monitor

The Mentor educational program presents basic instructions right on the monitor. Select *LEARN THE MONITOR* to open the first of six information windows.


OPERATING THE MONITOR
ROTATE the Trim Knob to HIGHLIGHT parameter labels (far right side of screen) and menu options (bottom of screen).
PRESS the Trim Knob to SELECT parameter labels and menu options. Related menu options will appear. A message line describing the highlighted menu option is displayed.
MAIN MENU
Select to return to main menu.
PREVIOUS MENU
Select to display previous menu.
Selecting HELP from a popup menu will display aninformation window.
NEXT WINDOW
CLOSE WINDOW
562A

Learn the Monitor Information Window

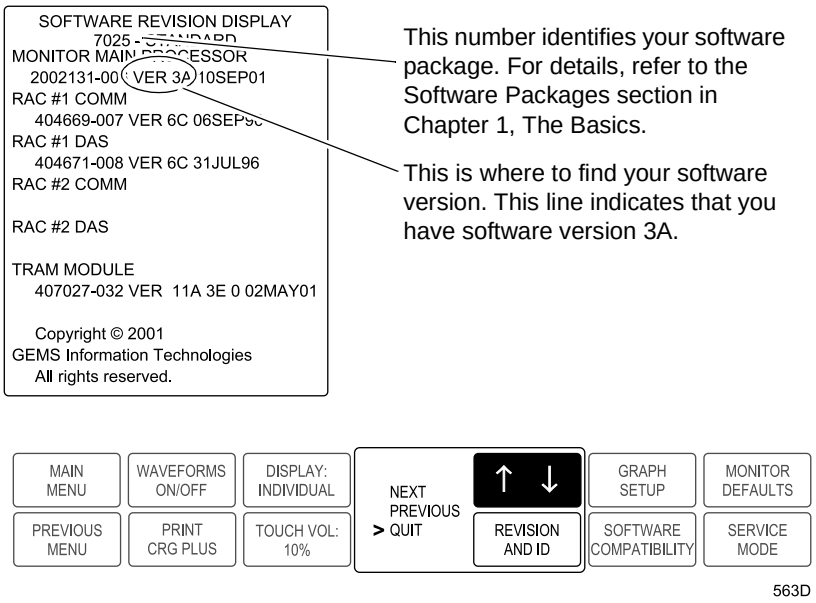
The six Mentor information windows are:

- Operating the Monitor
- Skin Prep and Electrode Placement
- Patient Status Alarms
- System Status Alarms
- Silencing Alarms and Graphing
- NBP Procedure and Zero Reference Procedure

When the Mentor information window is open, Trim Knob control and/or touchscreen operation is in the information window. *NEXT WINDOW* and *PREVIOUS WINDOW* enable movement forward and backward through the six windows. *CLOSE WINDOW* closes the Mentor information window. Mentor information windows cannot be printed.

Software Revision

To find out what software revisions (versions) are installed in your system, select the *REVISION AND ID* option from the Monitor Setup menu.



Software Revision Popup Menu and Information Window

The other software information in the information window is most useful to service personnel.

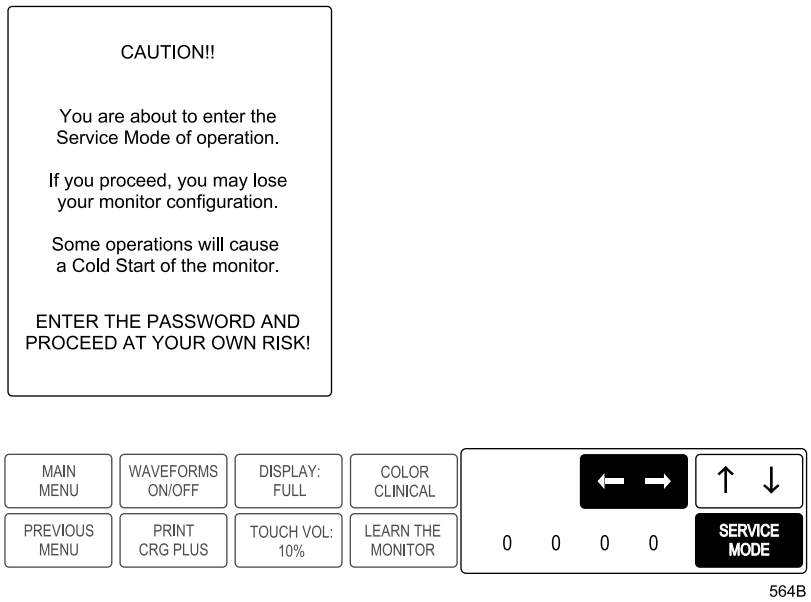
Select *QUIT* to close the popup menu and information window when you are done.

Software Compatibility

This menu option displays the monitor's main processor software and compatible component software. It is useful to service personnel when troubleshooting.

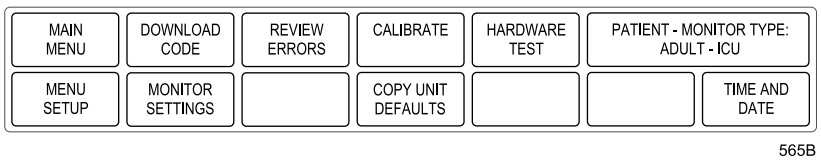
Service Menu

The Service menu is intended for qualified service personnel. Therefore, it is password protected. Selecting the *SERVICE MODE* option from the Monitor Setup menu displays a screen similar to the one shown below.


CAUTION!!
You are about to enter the Service Mode of operation.
If you proceed, you may lose your monitor configuration.
Some operations will cause a Cold Start of the monitor.
ENTER THE PASSWORD AND PROCEED AT YOUR OWN RISK!
MAIN MENU
WAVEFORMS ON/OFF
DISPLAY: FULL
COLOR CLINICAL
PREVIOUS MENU
PRINT CRG PLUS
TOUCH VOL: 10%
LEARN THE MONITOR
0 0 0 0
SERVICE MODE
564B

Service Mode Popup Menu and Information Window

After entering the password, the Service menu is displayed.



Service Menu

The service mode is used by qualified field engineers, service personnel, and hospital biomedical engineers to set up, troubleshoot, and repair the monitor. Refer to the appropriate service manual for more details.

The following Service menu items are mentioned in other places in this manual:

Patient-Monitor Type

Your monitor is set up for monitoring in one of three modes (patient-monitor types) with the *PATIENT-MONITOR TYPE* option:

- Adult-ICU (*ADULT*)
- Neonatal-ICU (*NEO*)
- Operating Room (*OR*)

The mode (patient-monitor type) appears next to the date and time at the top of the display.

When you change the patient-monitor type, any monitor defaults that have been set are lost, and the factory defaults are in effect again.

Menu Setup

Other options that affect the monitor are found in the Menu Setup option.

Admit Menu

The admit mode determines the menu options used when admitting a patient to the monitor. The admit modes are:

- Standard
- Rover
- Combo
- Rover Combo

Monitor Defaults Password

Monitor default password protection is used to restrict access to the Monitor Defaults menu. This feature can be enabled or disabled using this option. The choices are *REQUIRED* and *NOT REQUIRED*.

6 Admit/View A Patient

For your notes

About Admitting

Admitting a patient to the monitor is essential. Audible alarms are off and there are no alarm graphs or alarm history until the monitor is in the admit mode.

The following message is displayed near the middle of the screen to alert you to admit your patient:

ALL ALARMS OFF
ADMIT PATIENT TO ACTIVATE ALARMS

In addition to the message above, a discharge alert (beep) can be set in monitor defaults. The discharge alert sounds periodically when the monitor is in a discharged state and the display is on.

Monitor Applications

The monitor can be used in four ways:

- *STANDARD* — This application uses a monitor mounted in a room. It does not accommodate telemetry. A network connection is not required unless you have a central station.
- *ROVER* — This application allows you to move ("rove") the monitor to the patient, rather than moving the patient to a monitored room. It does not accommodate telemetry. A network connection is not required unless you have a central station.
- *COMBO* — With this application, ECG data can be acquired from either a module or a telemetry receiver system. A network connection is required.
- *ROVER COMBO* — This application combines the mobility feature of Rover monitoring with the telemetry compatibility of Combo monitoring. A network connection is required.

NOTE

The monitor's application is determined at installation. It is set using a menu option in the Service menu. Refer to the Solar 8000M Patient Monitor Service Manual for more information.

Guidelines for Combination Monitoring

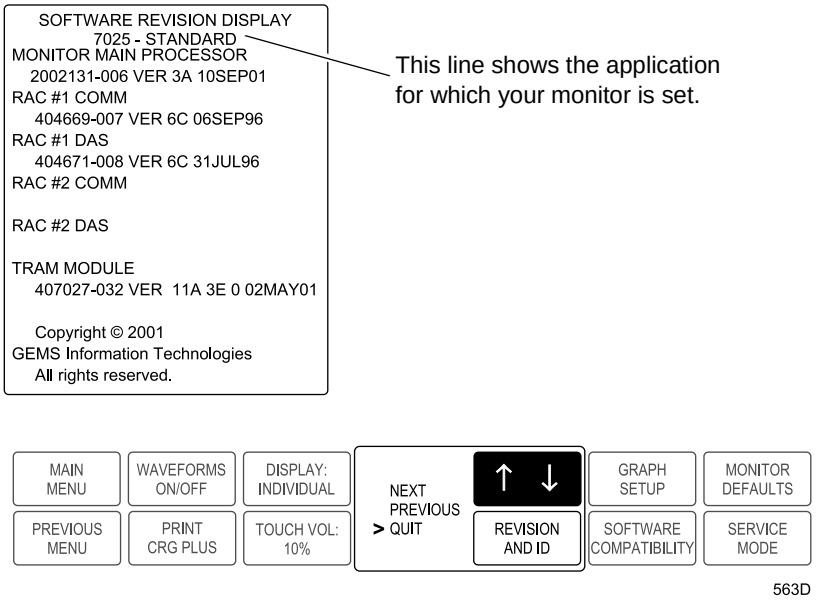
Here are some guidelines to remember when doing combination (Combo and Rover Combo) monitoring.

- When monitoring from telemetry, limits and alarm levels are the telemetry defaults (or telemetry defaults modified at the central station). However, you can adjust these settings at the monitor.
- When monitoring from telemetry, neither SpO2 data nor NBP data is sent to the monitor from the telemetry transmitter. If you wish to see telemetry SpO2 or NBP data, you must view the telemetry patient. Refer to the Viewing Other Patients section in this chapter.
- Arrhythmia alarm histories from the monitor are merged in the telemetry system when switching ECG monitoring from module to telemetry. (ApexPro software version 1 or later or CD Telemetry-LAN software version 5 or later is required.)
- When ECG monitoring is switched from telemetry to a Tram module, telemetry is automatically discharged and the 36 most recent alarm histories are transferred to the monitor.
- When ECG monitoring is switched from telemetry to an ECG/Resp module, the 36 most recent alarm histories are transferred to the monitor.
- When ECG monitoring is switched from telemetry to a module, the ECG limits, arrhythmia alarm levels, and display formats are recalled from monitor defaults.

For Which Application is the Monitor Set?

Follow these instructions to determine the application for which the monitor is set.

1. Select *MORE MENUS* from the main display.
2. Select *MONITOR SETUP*.
3. Select *REVISION AND ID*. A popup menu and information window are displayed.



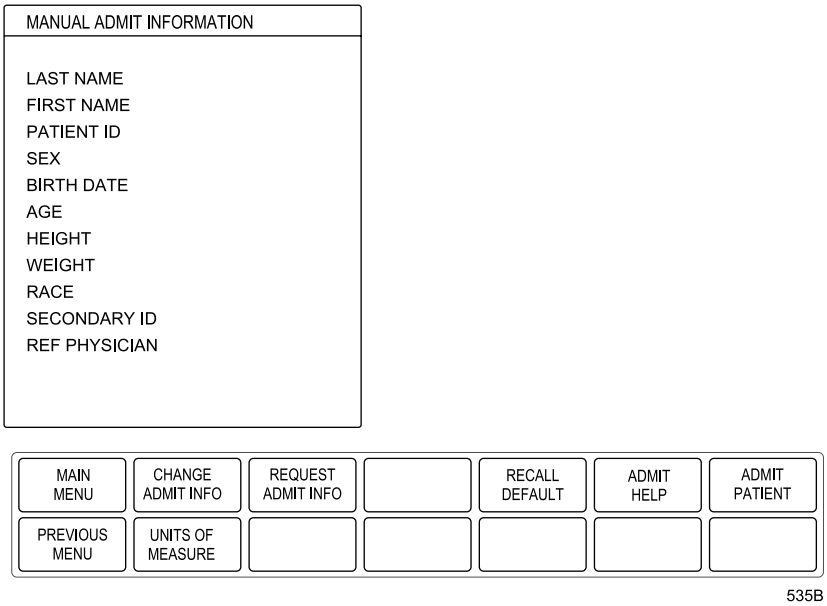
Software Revision Information Window

4. Select *NEXT* in the popup menu to view more software information, or select *QUIT* to close the popup menu and information window.

Admit Menus

The options available in the Admit menu vary depending on the application and patient-monitor mode for which the monitor is set.

To access the Admit menu, select *MORE MENUS* from the main display, then select *ADMIT MENU*. The Admit menu and information window are displayed.

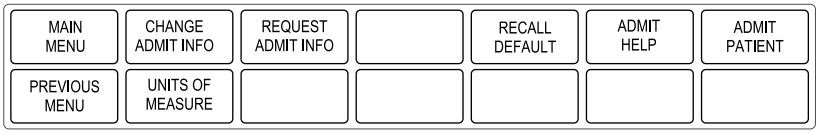


Admit Menu and Information Window

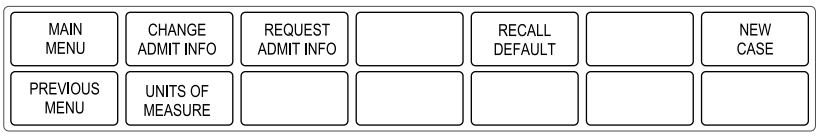
Standard Admit Menu

In the Standard application, the monitor is permanently assigned to a room. The unit name and bed number are assigned during installation.

Below are the standard admit menus, with options based on the patient-monitor mode.



Adult-ICU and Neonatal-ICU Admit Menu — Standard Application



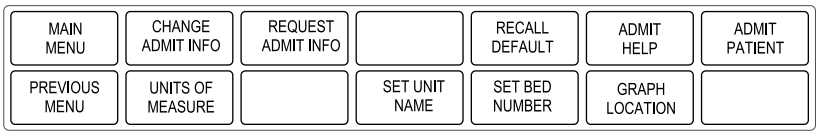
Operating Room Admit Menu — Standard Application

All menu options are described in the Admit Menu Options section in this chapter.

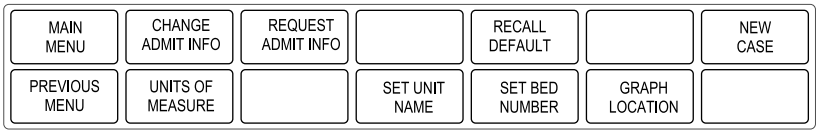
Rover Admit Menu

In the Rover application, the monitor can be moved from room to room. In some cases the unit name and bed number may need to be changed, so they are included as options in the admit menu.

Below are the Rover admit menus, with options based on the patient-monitor mode.



Adult-ICU and Neonatal-ICU Admit Menu — Rover Application



Operating Room Admit Menu — Rover Application

All menu options are described in the Admit Menu Options section in this chapter.

Combo Admit Menu

In the Combo application, the monitor is permanently assigned to a room, and patient data can be obtained from a module or from telemetry.

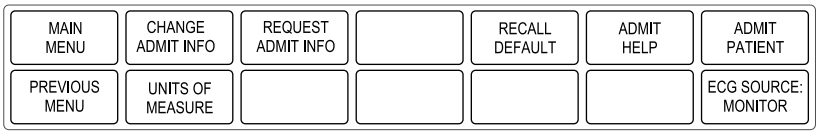
NOTE

The room must have a network connection to use telemetry.

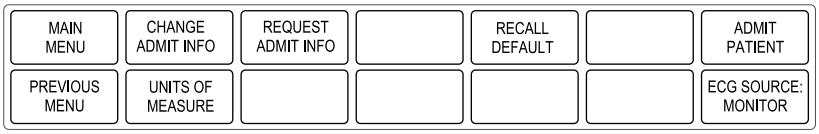
Below are the Combo admit menus, with options based on the patient-monitor mode.

NOTE

It is unlikely that this application would be used when the monitor is set for Operating Room mode. However, the Operating Room admit menu is shown below for your reference.



Adult-ICU and Neonatal-ICU Admit Menu — Combo Application



Operating Room Admit Menu — Combo Application

All menu options are described in the Admit Menu Options section in this chapter.

Rover Combo Admit Menu

In the Rover Combo application, the monitor can be moved from room to room, and patient data can be obtained from a module or from telemetry.

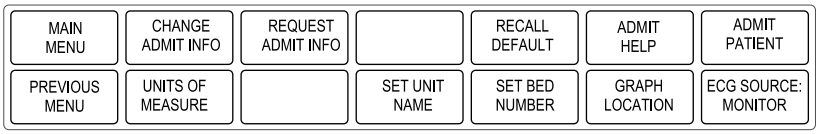
NOTE

A room must have a network connection to use telemetry.

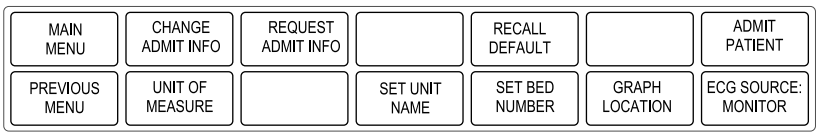
Below are the Rover Combo admit menus, with options based on the patient-monitor mode.

NOTE

It is unlikely that this application would be used when the monitor is set for Operating Room mode. However, the Operating Room admit menu is shown below for your reference.



Adult-ICU and Neonatal-ICU Admit Menu — Rover Combo Application



Operating Room Admit Menu — Rover Combo Application

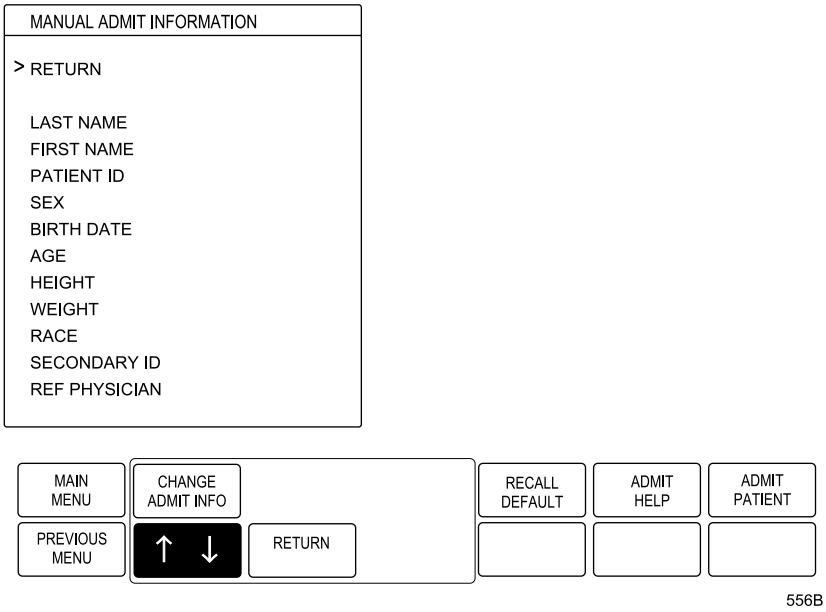
All menu options are described in the Admit Menu Options section in this chapter.

Admit Menu Options

Change Admit Info

The Change Admit Info menu option allows you to change or enter information pertinent to the monitored patient.

1. Select *CHANGE ADMIT INFO* from the Admit menu. A popup menu and information window open.



Change Admit Info Popup Menu and Information Window

2. Rotate the Trim Knob control or use the touchscreen arrows to move the pointer. Press, rotate, and press the Trim Knob control, or use the touchscreen arrows to enter characters and make selections. (Refer to Chapter 1, The Basics, for help with entering characters.)
3. Select *RETURN* when you are done. A prompt appears with the options *SAVE CHANGES* and *DO NOT SAVE CHANGES*. Selecting an option closes the information window.

The options in the Change Admit Info information window are:

- *LAST NAME, FIRST NAME* — Enter up to 16 characters for the patient's last name, and up to 10 characters for the patient's first name. At a minimum, part of the name appears on the monitor, the clinical information center, and graph headers.
- *PATIENT ID* — Enter up to 13 characters. It is important to enter this information if you have a MUSE system or a Solar Lab Access Server. If the patient ID is not entered, the monitor uses nine 9's (999999999) for MUSE storage.
- *SEX* — Select male or female.
- *BIRTH DATE* — Enter the patient's birth date. Age is then automatically calculated.
- *AGE* — Age is automatically calculated when the birth date is entered. It is calculated in years for adults. For neonatal and pediatric patients, age is calculated in days if age is less than 14 days, weeks if age is greater than 14 days but less than two years, and years if age is greater than two years. If you enter an age, birth date is calculated with the current day and month, and the appropriate birth year.
- *HEIGHT, WEIGHT* — Enter the patient's height and weight.
- *RACE* — Scroll through the selections in the popup window to select the patient's race.
- *SECONDARY ID* — If you need to enter a secondary ID, use this popup menu to enter up to 13 characters.
- *REF PHYSICIAN* — Enter up to 16 characters for the referring physician's name and/or number.

Admit Information Storage

Admit information is stored in the Tram module. The information stored includes the patient's name, ID, sex, date of birth, height, and weight. This information remains in the Tram module until patient discharge. If the Tram module is used for transport, the admit information automatically transfers with the module to the new bedside, as long as the patient ID has been entered.

Multiple Patient IDs

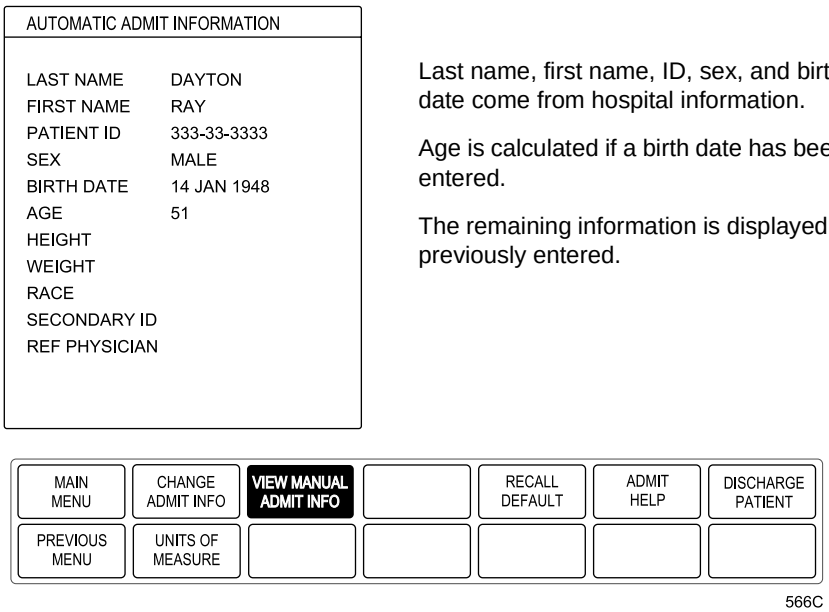
When using the Tram module for transport, the patient ID number transferred with the Tram module must match the patient ID number at the bedside. If the numbers do not match, a multiple patient ID information window is displayed.

There are three choices available in the multiple patient ID information window. They are:

- *CLEAR ADMIT INFORMATION* — This selection clears the admit information stored at both the bedside and the Tram module. You can then enter the correct patient identification information using the Change Admit Info menu option.
- Patient name and ID number stored in the Tram module — If you want to use the patient name and ID number that are currently stored in the Tram module, select the name and ID number that corresponds to that patient (e.g., 333-44-9999 SMITH).
- Patient name and ID number stored at the bedside — If you want to use the patient name and ID number that are currently stored in the bedside monitor, select the name and ID number that corresponds to that patient (e.g., 123-45-6789 CLARK).

Request Admit Information

If your monitoring system includes a Solar Lab Access Server or a MUSE ADT Server with an interface to hospital information, selecting the *REQUEST ADMIT INFO* option displays the patient information that was entered. If your system does not include this equipment, a message appears below the menu when you attempt to select this option.



Last name, first name, ID, sex, and birth date come from hospital information.

Age is calculated if a birth date has been entered.

The remaining information is displayed if previously entered.

Request Admit Info Information Window

Verify the accuracy of the displayed information. Use the *CHANGE ADMIT INFO* option if any information needs to be corrected or added.

NOTE

If you change information that was supplied automatically, you may have to notify the appropriate hospital personnel.

View Manual Admit Information

This option allows you to view admit information that has been entered manually. This menu option only appears when patient data is retrieved from a server with an interface to hospital information.

Recall Default

This menu option allows you to recall previously named monitor defaults while monitoring an admitted patient. Refer to Chapter 5, Monitor Setup, for more information.

ECG Source

This menu option is found in the Combo and Rover Combo admit menus. It is used to tell the monitor where to get the ECG information.

Selecting *ECG SOURCE* displays a popup menu and information window. The information window lists the sources from which ECG data can be obtained. Select *MONITOR* if the patient's ECG cable is connected to a Tram module or an ECG/Resp module. If the ECG source is telemetry, select the transmitter number that matches the one on the back of the transmitter.

NOTE

If you choose a transmitter number, you must admit the patient before the transmitter number will appear in the ECG parameter window.

Graph Location

The Graph Location option displays a menu that allows you to choose writers for alarm and manual graphs. Refer to the Graph Location section in Chapter 5, Monitor Setup, for detailed information about this menu option.

Set Unit Name

This menu option is found in the Rover and Rover Combo admit menus.

Having the correct unit name is important when sending information to central stations and writers. Verify that the unit name which appears at the top right of the display (CCU, ICU, etc.) is correct.

If it is not correct, select the *SET UNIT NAME* option. An information window is displayed, indicating the available unit names. Select the correct unit name and verify that it appears at the top of the display.

NOTE
If a unit name has not been entered, X's appear at the top of the display where the unit name normally appears.

NOTE
If the monitor is not on the network, a text entry popup menu opens. You can enter the unit name manually.

Set Bed Number

This menu option is found in the Rover and Rover Combo admit menus.

Having the correct bed number is important in identifying the monitor on the network. Verify that the bed number which appears at the top right of the display is correct.

If it is not correct, select the *SET BED NUMBER* option. An information window is displayed, indicating the available bed numbers. Select the correct bed number. If the bed number you need is not listed, select *CREATE NEW BED*. A text entry popup menu opens, in which you can enter the bed number manually.

NOTE
If a bed number has not been entered, X's appear at the top of the display where the bed number normally appears.

NOTE
If the monitor is not on the network, a text entry popup menu opens. You can enter the bed number manually.

Units of Measure

Selecting the *UNITS OF MEASURE* option opens an information window that allows you to change the units of measure used for the patient's height and weight. Options for *HEIGHT* are centimeters or inches. Options for *WEIGHT* are kilograms or pounds. The default settings are the metric units.

Select either *HEIGHT* or *WEIGHT* and to select the desired unit of measure. Select *RETURN* when you are finished.

In Neonatal-ICU mode, an additional option, *AGE*, also appears. The options are *DAYS*, *WEEKS*, and *YEARS*. The default setting is *WEEKS*.

Options for Admitting a Patient

Admit Patient

This menu option is found in all admit menus when the monitor mode is either Adult-ICU or Neonatal-ICU. It indicates that no patient is admitted. When this menu option is displayed, the monitor is in a discharged state, and there are no alarms.

Select *ADMIT PATIENT* to admit a patient. This is a direct action menu option.

New Case

This menu option appears only when the monitor is set for Operating Room mode.

It is a direct action menu option. When selected, both a discharge and an immediate admit are performed. All patient data from the previous patient is erased, the screen blanks for a few seconds, and the monitor is then ready to monitor the next patient.

Admit Help

Selecting the *ADMIT HELP* option opens an information window that provides admit instructions and shows the application for which the monitor is set. There are four admit help windows, one for each type of admit menu (Standard, Rover, Combo, and Rover Combo).

Quick Admit

The Quick Admit feature allows you to admit a patient by simply pressing the **Admit/Discharge** button on the keypad or remote control.

NOTE

This feature is only available in the Adult-ICU and Neonatal-ICU monitoring modes.

About Discharging

WARNING
DISCHARGE TO CLEAR PATIENT DATA — When admitting a new patient, you must clear all previous patient data from the system. To accomplish this, disconnect patient cables, and if you are using a Tram module, be sure it is locked in place in the Tram-rac housing, then do a discharge.

When you have finished monitoring a patient, a discharge procedure must be done to clear the system of all patient data. Monitor defaults are always recalled when a discharge is done. The last unit name and bed number used are also retained.

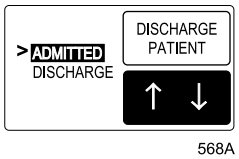
To discharge a patient, select *MORE MENUS*, then *ADMIT MENU*. Depending on your monitor's setup, you will see either *DISCHARGE PATIENT* or *NEW CASE*.

Discharge Patient — Standard and Rover Applications

This menu option is found in Standard and Rover admit menus. It indicates that a patient is admitted.

To discharge the patient, follow these steps.

1. Disconnect all patient cables.
2. Select the *DISCHARGE PATIENT* option from the Admit menu. A popup menu opens.



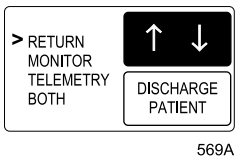
Popup Menu to Discharge

3. Select *DISCHARGE*. The message "*DISCHARGED*" appears at the top of the display, and all data is cleared from the system.

Discharge Patient — Combo and Rover Combo Applications

This menu option is found in Combo and Rover Combo admit menus.

1. Disconnect all patient cables.
2. Select the *DISCHARGE PATIENT* option from the Admit menu. A popup menu opens.



Popup Menu to Discharge

3. Select one of the four options from the popup menu.
   - *RETURN* — if you do not want to discharge the patient.
   - *MONITOR* — to discharge the patient from the monitor only. If ECG was from telemetry, it remains admitted, but is monitored only by the central station.
   - *TELEMETRY* — to discharge the patient from telemetry only. ECG automatically switches to the Tram module.
   - *BOTH* — to discharge the patient from telemetry and the monitor. If ECG was from the Tram module, *BOTH* affects only the monitor.

New Case

This menu option is displayed when the monitor is set for Operating Room mode. It is found in Standard and Rover admit menus.

This menu option clears patient information from the monitor. The monitor is then ready for the next patient with no additional steps.

1. Disconnect all patient cables.
2. Select *NEW CASE SETUP* to display the Admit menu.
3. Select *NEW CASE* from the Admit menu. Patient information clears and the monitor is automatically ready for the next patient.

Viewing Other Patients

The Solar 8000M patient monitor gives you the ability to be at one patient's bedside and view data from another patient's monitor. The care unit and monitor you want to view must be on the same Unity network as the monitor you are using.

NOTE

A monitor is identified by the bed number assigned. Therefore, the terms monitor and bed are used interchangeably.

The view other beds on alarm feature notifies you when a bed is in alarm so you can then select it to be viewed. Refer to the View Other Beds on Alarm section in this chapter.

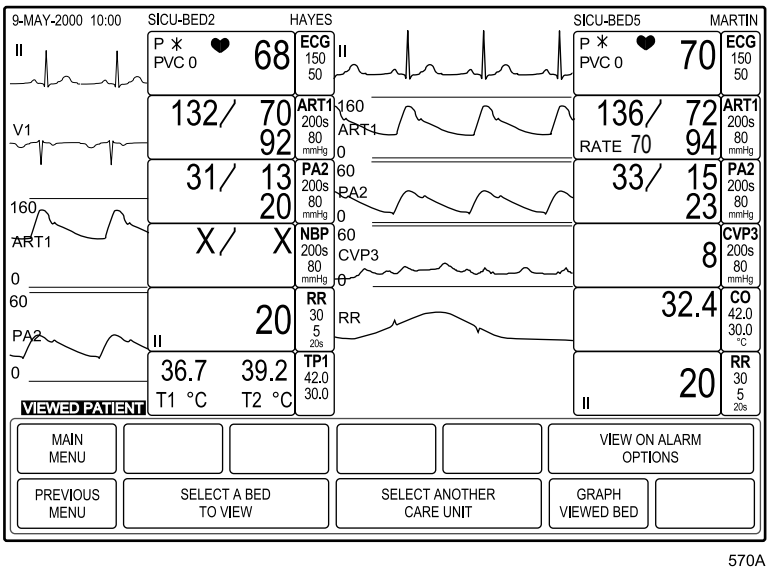
The figure on the following page is an example of the display when viewing another patient. The monitor you are viewing from is the "host." The patient data for the host monitor is always shown on the right. The viewed patient's data is always shown on the left. The message "*VIEWED PATIENT*" appears at the bottom of the viewed patient portion of the display. The unit and bed numbers, as well as the patient name if entered, are shown for both the host and viewed patient portions.

NOTE

The touchscreen option does not function on the viewed patient portion of the display.

The viewed patient data remains on the screen until turned off or until a different patient is selected. The first six parameter windows and up to four waveforms are displayed for the viewed patient.

All functions are operational for the host monitor. Two seconds of waveform data are displayed. However, the menus displayed are for the host monitor only, and if you access a function with an information window (e.g., limits), the viewed patient data is temporarily overwritten by the information window.



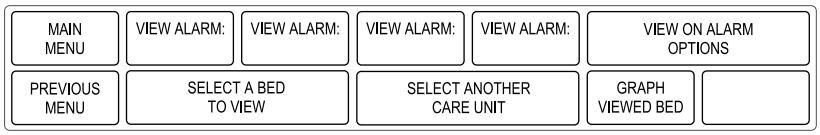
Viewed Patient Display

Here are some guidelines to remember when viewing another patient:

- Make sure the monitor to be viewed is admitted. If the monitor is discharged, waveforms are not displayed. Parameter windows and the message "*DISCHARGED*" are displayed.
- If monitoring CO2 on the host monitor, be sure that the CO2 waveform is positioned in the sixth, seventh, or eighth waveform position on the host monitor. Due to the slower CO2 waveform sweep speed, waveforms adjacent to or beneath the CO2 waveform on the viewed patient display will not appear.
- If monitoring CO2, Vent, and/or RM on the viewed monitor, the waveforms are not sent to the host monitor for viewing. The parameter windows, however, are sent to the host monitor for display.
- ST trends and complexes are not sent to the host monitor for viewing.
- If the CRG Plus display is currently on at the viewed monitor, two waveforms and six parameter windows are sent to the host monitor. The CRG Plus display is not sent.

View Other Patients Menu

Select *VIEW OTHER PATIENTS* from the Main menu to display the View Other Patients menu.



View Other Patients Menu

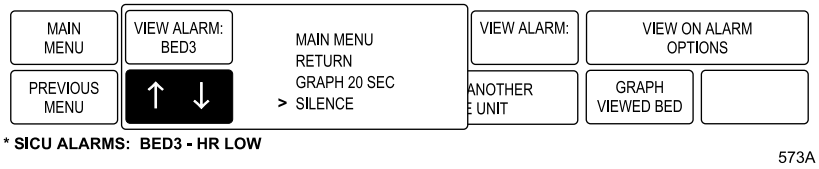
- *VIEW ALARM* — Select to display the patient data for the bed in alarm. These menu options do not appear when the view on alarm feature is turned off.
- *VIEW ON ALARM OPTIONS* — Displays a new menu that allows you to turn the view on alarm options on, off, or set to auto.
- *SELECT A BED TO VIEW* — Opens an information window from which you can select a bed to view.
- *SELECT ANOTHER CARE UNIT* — Opens an information window from which you can select another care unit. This affects the list viewed in the select a bed to view option.
- *GRAPH VIEWED BED* — Starts a 20-second graph of the viewed patient's data.

These options are described on the following pages.

View Alarm

The View Alarm options allow quick display of the data for a bed that is experiencing an alarm.

Select the View Alarm option that lists the alarming bed you want to view. A bed number does NOT appear in a View Alarm menu option unless there is an alarm. In the example below, Bed 3 is alarming.



View Alarm Popup Menu

The choices in the popup menu are:

- *MAIN MENU* — Closes the patient view and returns to the main display.
- *RETURN* — Closes the patient view and returns to the View Other Patients menu.
- *GRAPH 20 SEC* — Starts a 20-second graph strip of the viewed patient data.
- *SILENCE* — Silences alarms for 60 seconds at the monitor that is the source of the viewed patient data.

  NOTE

  You cannot silence an alarm in the Operating Room mode.

View On Alarm Options

Select *VIEW ON ALARM OPTIONS* to display a new menu with options for viewing other beds on alarm. The options in the menu are:

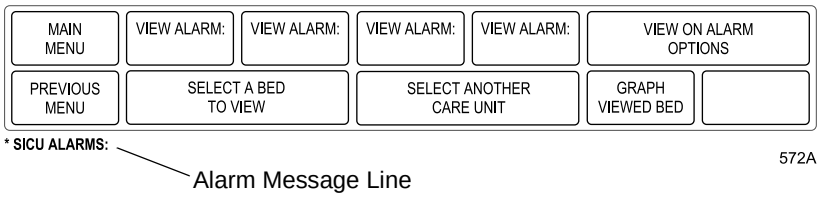
- *VIEW OTHER BEDS ON ALARM* — Opens a popup menu that allows you to turn this feature on and off, or use the automatic view on alarm feature.
- *SEND AUTO VIEWS* — Turns on/off automatic viewing of local beds in alarm throughout the care unit.
- *ALERT TONE* — Turns on/off the automatic view on alarm audio signal.

View Other Beds on Alarm: On

NOTE

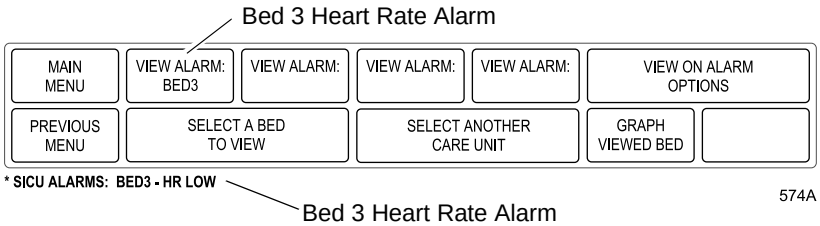
This feature only identifies crisis and warning alarms.

This feature defaults off, but can be set to on or auto in Monitor Defaults. When it is on, an alarm message line is displayed immediately below the menu area of the display. While on, it is displayed below all menus.



Alarm Message Line with No Beds in Alarm

When a bed in the unit alarms, the bed number and reason for alarm are displayed on this message line. The first View Alarm option in the menu also shows the bed in alarm.



Alarm Message Line with a Bed in Alarm

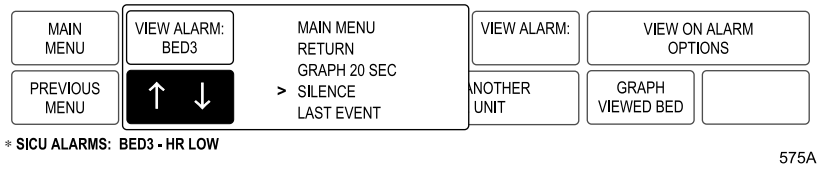
If multiple alarms occur, the beds with the most recent alarm and highest alarm levels are displayed and prioritized, with the highest priority alarm displayed first. A maximum of four beds can be displayed in the message line at any one time.

View Other Beds on Alarm: Auto

NOTE

The Prism server is required for the automatic view on alarm feature.

The automatic view on alarm feature is activated when a patient crisis, patient warning, or system warning alarm occurs. All beds in the unit with view other beds on alarm set to auto automatically enter a full or split-screen view of the alarming bed, and the automatic view on alarm popup menu opens.



Automatic View on Alarm Popup Menu

The choices in the popup menu are:

- *MAIN MENU* — Closes the auto view and returns to the main display.
- *RETURN* — Closes the auto view and returns to the view other patients menu.
- *GRAPH 20 SEC* — Starts a 20-second graph strip of the viewed patient data.

- *SILENCE* — Silences alarms for 60 seconds at the monitor that is the source of the viewed patient data.

  NOTE
  Alarms cannot be silenced in the Operating Room mode.

  CAUTION
  When view other beds on alarm is in auto mode, alarms must be silenced at the alarming bed or at a host bed before the next alarm can be viewed.

  If the alarm is silenced from the popup menu, the automatic view is removed from each monitor in the unit. The monitor from which the the alarm was silenced retrieves the parameter and waveform data directly from the alarming bed and displays it as a viewed patient.

  Alarms silenced at the central station or at the alarming bed cause all automatic views to be terminated. If the alarm condition exists after the silence period, or if a new alarm occurs, all other beds return to the automatic view. The bed which initially silenced the alarm will only view new alarms if the automatic view on alarm popup menu was closed before the new alarm occurred.

- *LAST EVENT* — Retrieves the last arrhythmia event from the alarming bed. The event is then displayed in a standard history display, with an *OK* popup menu. When selected, the popup menu clears the history display and returns to the view other beds on alarm menu.

Select a Bed to View

To view a bed that is not in alarm, select the *SELECT A BED TO VIEW* option from the View Other Patients menu. A popup menu and information window open, displaying all the available beds for one unit. (Refer to the Select Another Care Unit section in this chapter for information about changing care units.)

Select the bed you want to view. The display reconfigures to show the selected patient data on the left. The popup menu closes and the main menu is displayed. Menu items displayed are for the host monitor only.

Turn the View Off

To turn the viewed bed off, select the *SELECT A BED TO VIEW* menu option. The information window will appear with the pointer (>) already in front of the viewed bed. Simply select the viewed bed to turn off the view and close the information window.

Select Another Care Unit

If the patient you want to view is in another care unit, select the *SELECT ANOTHER CARE UNIT* option to display a popup menu and an information window that lists all care units on the network. In the information window, select the care unit you want. The popup menu and information window close. You must then designate the bed to view using the Select A Bed To View menu option. (Refer to the Select a Bed to View section in this chapter.)

Graph Viewed Bed

Select this option to start a 20-second graph of the viewed patient data. The waveforms that appear on this graph are those selected in the Graph Setup menu on the viewed patient's monitor. If there is a local printer attached to the host bed, the graph prints there. Otherwise, the graph is printed to the device selected for manual graph location on the viewed patient's monitor.

Full Patient View

Normally, there is a split screen view when viewing another bed at a host monitor. However, it is possible to have a full screen view of another bed under these circumstances:

- No modules are in the Tram-rac housing at the host monitor.
- The host monitor must be in a discharged state.
- A bed to view is selected from the View Other Patients menu at the host monitor.

When using the full screen for viewing a patient, the following conditions apply:

- All monitored parameters are received from the viewed bed.
- Up to eight waveforms are received from the viewed bed. No waveforms are received for Vent, RM, CO2 and other gas parameters, ST trends and complexes, or CRG Plus display.
- No audible alarms sound, but normal visual indications of an alarm occur.
- The bed name and patient name for the viewed bed are displayed rather than those for the host bed.
- The message "*VIEWED PATIENT*" is always displayed at the bottom of the screen.
- The Alarm Control menu and the Admit menu cannot be accessed.
- Parameter priorities as defined in the host monitor's default settings affect the order of parameter display.
- Touchscreen capabilities are not active.

From the host monitor you can:

- Select patients to view in any care unit.
- Graph patient data. To initiate a graph, do one of the following:
  - Select the *GRAPH VIEWED BED* option in the View Other Patients menu. This starts a timed graph using waveform, location, and speed settings as set at the viewed patient's monitor.
  - Press the **Graph Go/Stop** button. This starts a graph using the location, speed, and timing settings at the host monitor. The waveforms graphed are the monitor defaults at the host monitor.

NOTE

To change the graph settings at the host monitor, you must stop viewing the patient. Once the changes are made, you can view again.

- Access most options in the Monitor Setup menu.
  - Print CRG Plus is not available.
  - The options in this menu can be used to configure the host monitor differently. However, any changes made do not affect the viewed patient's monitor.

- Access the following patient data:
  - Alarm histories (you cannot delete events)
  - Graphic trends
  - Vital signs (you cannot sort data)

- Scale (size) some waveforms: If a waveform can be scaled or sized, a scale (size) selection is available in the parameter menu.

  NOTE

  Scaling occurs only at the host bed. The scale (size) at the viewed bed is not affected.

7 Printing

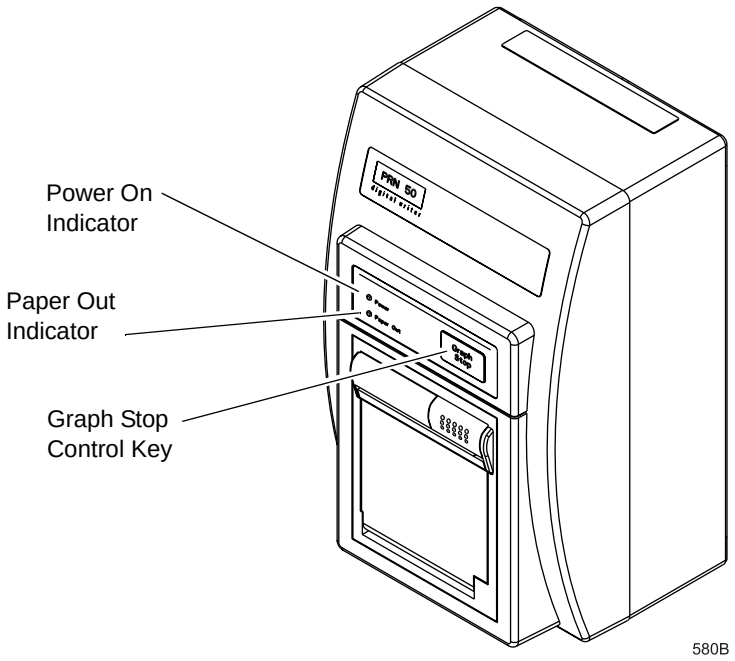
For your notes

Writers and Printers

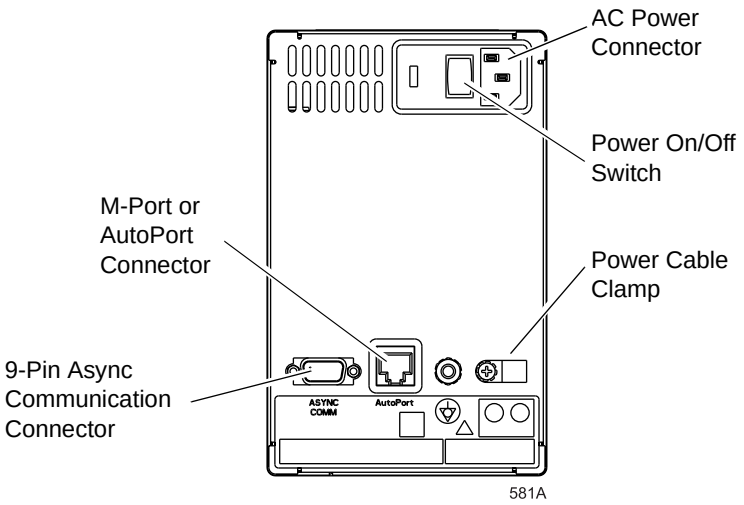
Optional, stand-alone writers and printers can be used with the monitor. The writer or printer is connected by cable to the monitor or to a central station.

PRN 50 Digital Writer

The optional PRN 50 digital writer uses 2-inch paper. There are two indicator lights and one control key on the front. The power switch and connectors are on the back.



Front View of the PRN 50 Digital Writer



Back View of the PRN 50 Digital Writer

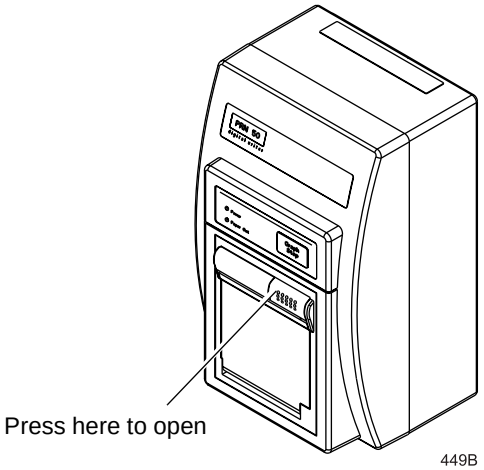
M-Port and AutoPort PRN 50 Digital Writers

There are two types of PRN 50 digital writers. The older writers, labeled PRN 50, use an AutoPort connector. This connector is located on the back of the PRN 50 digital writer, and is labeled **AutoPort**. Use of this type of PRN 50 digital writer with the Solar 8000M monitor requires an AutoPort adapter. This adapter (part number 2001973-001) plugs into the AutoPort connector on the PRN 50 writer.

The newer PRN 50 digital writers are labeled PRN 50-M, and they use an M-Port connector interface. This connector is located on the back of the PRN 50-M digital writer, and is labeled **M-Port**. The PRN 50-M digital writer does NOT require an adapter to be used with the Solar 8000M monitor. Simply connect it to one of the M-Port connectors on the front of the Solar 8000M monitor.

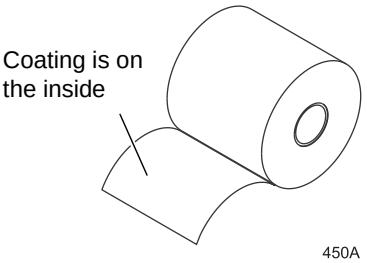
Changing the PRN 50 Digital Writer Paper

1. Open the door by pressing on the top of the door, as indicated below.



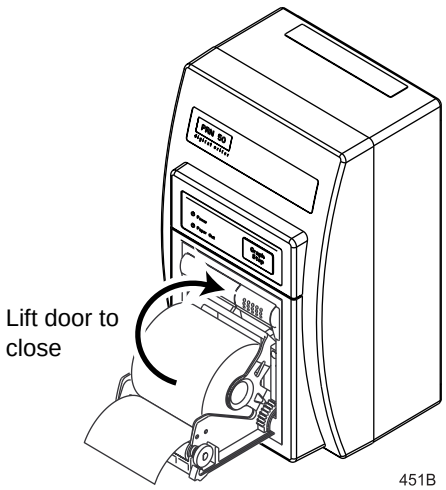
449B

2. Remove the old paper spool and install a new roll. The paper contains a special coating on one side and must be installed correctly. Install the paper so it unrolls from the bottom.



450A

3. Close the door and make sure the paper protrudes through the opening.
4. Test the writer by starting a graph strip.



451B

NOTE

If the graph strip is blank, the paper is probably installed upside down. Turn the spool over so the paper unwinds from the top.

Laser Printer

An optional laser printer can be connected to the Clinical Information Center (central station). When choosing a graph location, it is identified on the monitor as *LASER*.

The laser printer prints the following information when it is selected for each graph location:

- Print window location — Any printable information window being displayed is printed when the **Graph Go/Stop** button is pressed.
- Manual graph location — The waveforms, as selected in the Graph Setup menu, are printed when the **Graph Go/Stop** button is pressed. Twenty seconds of waveforms per page are printed in cascade format when the graph speed is set to 25 millimeters per second. The graph runs until all patient data is printed.

  NOTE

  There is a delay of approximately one minute until the first page is printed. This delay does not mean that the data printed is delayed. This delay is simply the time it takes for the laser printer to process the information. The amount of data printed and the length of the delay increase if a graph speed slower than 25 mm/s is chosen.

- Alarm graph location — An alarm-activated graph provides 20 seconds of waveforms per page in cascade format. The graph runs for the duration of the alarm. There is a delay of approximately one minute until the first page is printed (see note above).

Graphing

Patient waveforms and most information windows can be printed. You choose which waveforms to print, to which device to print, graph duration, and the speed at which manual graphs are printed. The menu options for setting these are found in the Graph Setup menu. Refer to Chapter 5, Monitor Setup, for more information.

Manual Graphs

Waveforms and information windows are printed when the **Graph Go/ Stop** button on the keypad or remote control is pressed. The message "*GRAPHING MANUAL*" or "*PRINTING WINDOW*" is displayed when a manual graph is requested. The Graph Setup menu has an option that allows you to set the time for a manual graph run (e.g., continuous, 20 seconds, etc.).

NOTE

A one millivolt ECG signal at normal size (1X) equals 10 millimeters on the graph paper.

NOTE

All waveforms on a graph strip begin with 10 seconds of delayed data. The header information printed with the waveforms is real-time data.

Exclusive Graph Control

Once a manual graph is started, it can only be stopped at the same source from which it was started, or by the **Graph Stop** key on the writer. This prevents two people at different sources from starting a graph at the same time, which would result in one turning the graph on and the other turning it off.

Alarm Graphs

A graph strip is automatically printed when a crisis or warning alarm occurs. An arrhythmia alarm graph runs until a normal sinus rhythm is detected or until you manually stop the graph. Any other alarm graph runs for 20 seconds or until you manually stop the graph.

NOTE

To convert an arrhythmia alarm graph to a manual graph, you must stop the graph using the **Graph Stop** key on the writer, then immediately restart the graph.

The graph on alarm default is off. The Alarm Graph menu option in the Graph Setup menu turns this feature on and off. It can be saved as a monitor default.

Invasive BP Only

The user has the option to graph invasive blood pressures only. In the graph BP invasive mode, the BP waveforms are the only printable parameters. The waveforms are graphed on one scale using the full grid space. Refer to Chapter 5, Monitor Setup, for more details.

Pressure Scales

Invasive pressures are graphed on individual mode or full mode scales, depending on the display of the waveforms. If the BP waveform is displayed in full mode or full grid mode, it is graphed in full mode. If the BP waveform is not displayed or displayed in individual mode, it is graphed in individual mode. Invasive pressures are graphed on individual scales as follows:

Displayed Scale	Graph Scale
30	0-45 (PA, CVP, LA, RA, ICP)
40	0-45
60	0-60
100	0-90
160	0-150
200, 300	0-300
Auto	0-150 (ART, FEM, UAC, SP) 0-45 (PA, CVP, UVC, RA, LA, ICP)

Graphing Messages

The following messages may appear when graphing:

- *SAVING* — The device to which you want to print is busy or inoperable. If you are printing an alarm graph, 20 seconds of data are saved until the device can print or another alarm graph occurs. The monitor only saves the most recent alarm data for printing. A manual graph is saved until you press the **Graph Go/Stop** button or an alarm graph occurs.
- *GRAPHING BP* — Only invasive blood pressures are being graphed.
- *GRAPHING MANUAL* — A manual graph is in progress.
- *GRAPHING ALARM* — A crisis or warning alarm has occurred and an automatic alarm graph is running.
- *PRINTING WINDOW* — A manual graph of a printable information window is in progress.
- *NO PAPER* — The writer or printer needs paper, or the writer door is open.

Graph Header

The graph header, which is printed with all patient waveforms, includes:

- Type of graph (alarm, manual, or BP only)
- Alarm violation (if any)
- Unit name, bed number, and patient name
- Patient ID
- Date and time
- Patient-monitor type and monitor default name
- Alarm volume level (%)
- Graph speed
- Lead failed (if any)
- Heart rate
- Arrhythmia call (if any, and arrhythmia is on)
- Pace mode (if on)
- Arrhythmia mode (off, lethal, or full)
- PVC count (if full arrhythmia is on)
- ST value for top displayed lead (if on)
- ST measurement point (if on)
- ECG filter (Hz range)
- Values for all other monitored parameters

For your notes

8 Alarm Control

For your notes

Smart Alarms

Alarm processing is not activated until the monitor has detected valid physiologic data from the patient. This allows you to admit a patient and proceed with necessary patient connections without bothersome alarm tones. If a new parameter is added during monitoring, for example, pulse oximetry, the alarm processing for that parameter is not active until valid physiologic data is detected.

NOTE

To properly use the smart alarm feature, be sure to remove all patient cables connected to the monitor prior to discharging. This assures that no data is seen after a discharge.

WARNING

After an interruption of the electric power supply (e.g., for an emergency power test), you must check whether alarm processing is active again, and whether an arrhythmia has occurred while the power supply was interrupted.

Alarm Structure

The monitor's alarm structure is divided into two classifications:

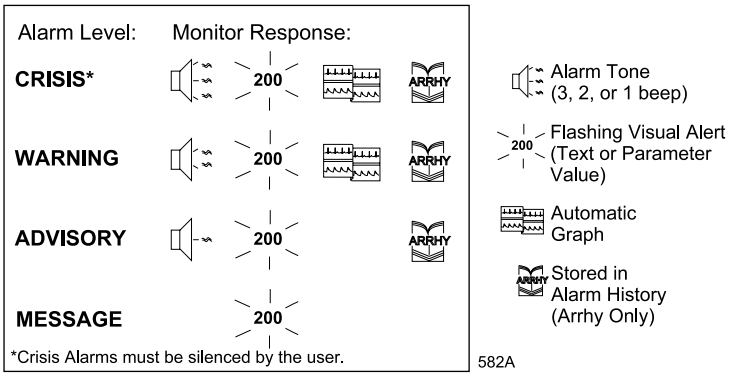
- Patient status alarms
- System status alarms

Within each classification, there are levels that correlate to the severity of the alarm-causing condition. The levels and how the monitor responds to each are described below. In most cases, patient status alarms can be moved from one level to another. Refer to the Arrhythmia Alarm Level and Parameter Alarm Level sections in this chapter.

Patient Status Alarms

Patient status alarms are triggered by a patient condition that exceeds parameter limits or by an arrhythmia condition. Patient status alarms provide you with the highest priority information.

The levels within the patient status alarm category and how the monitor responds to each are shown in the following chart. The chart begins with the most critical type of alarm, Crisis, and ends with the least critical type of alarm, Message.



Patient Status Alarms Chart

Crisis, Warning, and Advisory alarms sound an alarm tone and display a flashing, white-on-red visual alert. No alarm tones sound for message alarms, but the flashing, white-on-red visual alert appears on the display.

NOTE

For monitors without arrhythmia detection: For patients at risk of asystole, it is recommended that you assign the heart rate alarm to the Crisis level. When assigned to the Warning level, the HR alarm clears automatically after three minutes in cases of continued asystole.

The automatic graph on alarm feature can be set to on or off as a monitor default. Refer to Chapter 5, Monitor Setup.

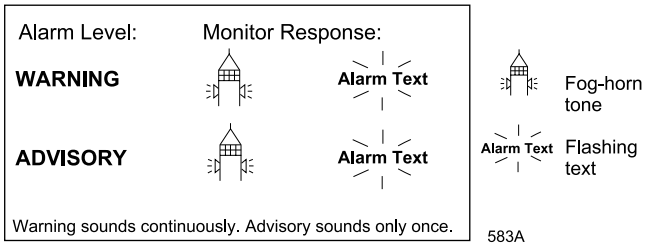
Remote Alarm Terminal

If a remote alarm terminal (nurse call system) is connected to an M-port, it will be activated when a patient status alarm occurs. The alarm level that activates the remote alarm terminal is determined by the Remote Alarm Level setting in Monitor Defaults, under the Setup Default Display option.

- Crisis (default) — Only Crisis level alarms activate the remote alarm terminal.
- Warning — Both Crisis and Warning level alarms activate the remote alarm terminal.
- Advisory — Either a Crisis, Warning, or an Advisory level alarm activates the remote alarm terminal.

System Status Alarms

System status alarms are triggered by mechanical or electrical problems and are of lesser priority than patient status alarms. The levels within the system status alarm category and how the monitor responds to each are shown in the following chart.



System Status Alarms Chart

System status alarms cannot, in most cases, be moved from one level to another.

Warning alarms sound continuously and must be silenced by the user.

NOTE

If a remote alarm terminal (nurse call system) is connected to an M-port, it will be activated when a Warning level system status alarm occurs.

On-screen Alarm Help

The alarm structure information can be displayed on the monitor, and you can hear the tones associated with each level. Refer to the Alarm Help section in this chapter for more details.

Controlling Audio Alarms

Using the *SETUP DEFAULT DISPLAY* option in the monitor defaults menu, the function of the **Silence Alarm** button can be set to *NORMAL* or *SILENCE ONLY*.

Silencing Alarms

When set to *SILENCE ONLY*, the **Silence Alarm** button works as a silence button.

- Press once to silence alarms.
- Press again to reactivate alarms.
- Pressing this button when no alarms are occurring has no effect.

The current alarm is silenced for 60 seconds, and the message "*SILENCED*" is displayed on the screen.

The silence command is cancelled and the alarm tone will sound when any new ECG or arrhythmia alarm of an equal or higher level occurs.

An Alarm Pause menu option is available when *SILENCE ONLY* is selected. Refer to the Pausing Alarms section in this chapter.

Pausing Alarms

When set to *NORMAL*, the **Silence Alarm** button works as an ***alarm pause*** button.

WARNING
Alarms do not sound, alarm histories are not stored, alarm graphs do not print, and alarms are not sent to the Clinical Information Center during an "Alarm Pause" condition.

NOTE
When the crisis alarm pause breakthrough feature is turned on, crisis alarms do sound during an alarm pause condition. Refer to the Crisis Alarm Pause Breakthrough section in this chapter.

- When pressed once, it silences a current, audible alarm for 60 seconds.
- When pressed twice during an alarm, it starts a 5-minute alarm pause in the Adult-ICU mode (3 minutes in Neonatal-ICU mode and when the monitor's language is set to *French-France*). A countdown timer is displayed on the screen. During the alarm pause, press the button again to reactivate alarms.
- If no alarm is sounding, press it once to start an alarm pause as described above.
- If the monitor is set up for Operating Room mode, there are three levels of alarm pause:
  - Press the button once (twice if an alarm is sounding) to start a 5-minute alarm pause;
  - Press again to start a 15-minute alarm pause;
  - Press again to start a permanent alarm pause;
  - Press again to reactivate alarms.

Alarm Pause Breakthrough

The alarm pause breakthrough feature allows any crisis level alarm to "break through" (interrupt) an alarm pause with an audible alarm.

In other words, when this feature is turned on (set to *CRISIS*) in the Setup Display Defaults window found in Monitor Defaults, crisis level alarms will sound, even if an alarm pause is in effect.

NOTE

Only alarms set to crisis level can break through an alarm pause. Alarms set to any other alarm level will not break through the alarm pause, even when the feature is turned on.

When a crisis alarm breaks through an alarm pause, arrhythmia histories are not stored.

This feature is labeled as *PAUSE BREAKTHRU* in the Setup Display Defaults window. It can be set to *CRISIS*, which indicates that the alarm pause breakthrough feature is active, or *OFF*, in which case no alarms will break through an alarm pause.

NOTE

Crisis alarms do not break through an alarm pause caused by selecting the *DISPLAY OFF/ALARM PAUSE* option from the Alarm Control menu. The Display Off/Alarm Pause feature is intended for use when a patient is disconnected from the monitor. Therefore no alarms break through this type of alarm pause.

Turning Alarm Volume Off Permanently

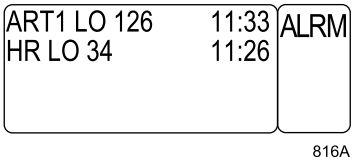
Refer to the Alarm Volume section in this chapter for information about turning alarm volume off permanently.

Alarm Window

NOTE

This feature defaults off when the monitor is set for Operating Room mode. It can be turned on with the Parameters On/Off option in the Monitor Setup menu.

The alarm window, which is displayed when you admit a patient to the monitor, is used to automatically record any patient status alarm set for crisis, warning, or advisory level. The four most recent alarms are displayed in chronological order, along with the extreme parameter value and time stamp.



Alarm Window

The extreme numerical value for all active, displayed alarms is continously updated. Active alarms are displayed in red. Upon resolution of an active alarm (patient condition reverts to within set limits), the alarm text is displayed in the color associated with that parameter.

To turn off the display of this window, use the Parameters On/Off menu option in the Monitor Setup menu. The alarm window always defaults on when you admit a new patient.

Clear Alarms

Information displayed in the alarm window remains until it is manually cleared or the patient is discharged from the monitor.

To manually clear the information, select the *ALRM* label to display the Alarm Control menu. The *CLEAR ALARMS* option is already highlighted. Select it to clear the data and exit the menu.

Alarm Histories

NOTE

This option is part of the Cardiac software package.

Any arrhythmia alarm set for the crisis, warning, or advisory level is stored in Alarm History. ST references and ST alarms are also stored in Alarm History.

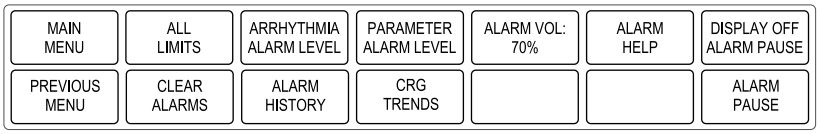
To view alarm histories, select the *ALRM* label to display the Alarm Control menu. Then select the *ALARM HISTORY* option to display a list of arrhythmia and ST events.

For more details, refer to the Alarm History section in this chapter.

Alarm Control Menu

There are two ways to access the Alarm Control menu:

1. Select *MORE MENUS* from the main display, then select *ALARM CONTROL* to display the Alarm Control menu, OR
2. Select the *ALRM* label in the alarm window to display the menu.



Alarm Control Menu

- *ALL LIMITS* — Displays a screen of all currently monitored parameters and their alarm limits, as well as the unit of measure for each. Alarm limits can also be changed.
- *ARRHYTHMIA ALARM LEVEL* — Displays arrhythmia alarm levels. Can be adjusted to other levels.
- *PARAMETER ALARM LEVEL* — Displays parameter alarm levels. Can be adjusted to other levels.
- *ALARM VOL* — Adjusts the volume of the alarm tone.
- *ALARM HELP* — Displays on-screen help describing patient status alarms and system status alarms.
- *DISPLAY OFF ALARM PAUSE* — Turns the display off and pauses alarms at the central station for this monitor.
- *CLEAR ALARMS* — Clears the information displayed in the alarm window.
- *ALARM HISTORY* — Displays stored arrhythmia alarm events (Cardiac software package only).
- *CRG TRENDS* — Displays high-resolution CRG trends data and the CRG trends menu. (High Resolution CRG Trends software package only.)
- *ALARM PAUSE* — Starts and stops an alarm pause. This option is only available when the Silence Alarm default setting is set to *SILENCE ONLY*. (Refer to the Setup Default Display section in Chapter 5, Monitor Setup, to set the Silence Alarm default.)

All Limits

The All Limits menu option allows you to view the high and low alarm limits and unit of measure for each parameter currently monitored. You can change the limits for any monitored parameter without having to go into each individual parameter menu.

To view the All Limits information window, select *ALL LIMITS* from the Alarm Control menu. An information window is displayed, showing a list of patient parameters currently being monitored, their units of measure, and their current high and low limits. Only parameters currently being monitored are listed.

Changing a Limit

To change one or more limits in the All Limits information window, follow the procedure below. All changes made with this menu option are temporary and revert to the default settings upon patient discharge.

1. Select the parameter you wish to change.
2. Highlight the high or low limit.
3. Change the limit value.
4. Press the Trim Knob control to complete the change. The new limit takes effect immediately.
5. Rotate the Trim Knob control to highlight the parameter label, then press it to unhighlight. You can now move to another parameter if you want.

NOTE

Steps 4 and 5 are not needed when using the optional touchscreen. Simply use the touchscreen arrows to move around the information window.

6. When you are finished making changes, select *RETURN* to close the information window.

Arrhythmia Alarm Level

The arrhythmia calls recognized by the monitor are assigned to one of four patient status alarm categories. The Arrhythmia Alarm Level option allows you to view the levels assigned to each arrhythmia call.

To display a list of arrhythmia calls and their assigned alarm levels, select *ARRHYTHMIA ALARM LEVEL* from the Alarm Control menu. An information window is displayed, showing a list of the arrhythmia calls on the left, with their corresponding alarm levels on the right. A popup menu also opens.

The software package and the monitor default settings determine what arrhythmias are listed.

Most arrhythmia alarms can be moved to other levels. Refer to the Selecting Options from Scroll Lists section in Chapter 1, The Basics, for the procedure to change alarm levels.

Any changes made with the Arrhythmia Alarm Level menu option are temporary and revert to the default settings upon patient discharge.

NOTE

In the Basic software package, only Asystole, VFIB/VTAC, and V Tach appear. Only V Tach can be moved to another level. All other arrhythmia calls appear and are adjustable in the Cardiac software package.

NOTE

Asystole and ventricular fibrillation (*V FIB / V TAC*) cannot be moved in the Adult-ICU or Neonatal-ICU mode.

Parameter Alarm Level

Parameter alarms are assigned to one of four patient status alarm categories. The Parameter Alarm Level option allows you to view and reassign parameter alarms to other levels.

To move a parameter alarm to another level, use the *PARAMETER ALARM LEVEL* option and follow the procedure described in the Selecting Options from Scroll Lists section in Chapter 1, The Basics.

Any changes made with this menu option are temporary and revert to the default settings upon patient discharge.

NOTE

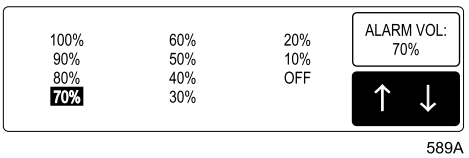
No waveforms are stored in Alarm History for parameter alarms.

Alarm Volume

NOTE

When adjusting alarm volume, carefully consider the environmental noise level. Adjust the volume so the clinician can adequately hear alarms.

To adjust alarm tone volume, select *ALARM VOL* from the Alarm Control menu. A popup menu opens, displaying the volume settings.



Alarm Volume Popup Menu

Each time a different volume setting is highlighted, you hear a tone at that volume. The message "*ALARM VOLUME OFF*" is displayed at the top of the screen if *OFF* is selected.

NOTE

The Alarm Volume options shown are dependent on the Min Alarm Volume and Alarm Volume Off settings in the Setup Display window found in Monitor Defaults.

In the Operating Room and Neonatal-ICU modes, the 10% volume tones are slightly quieter than the same tones in the Adult-ICU mode.

When you are satisfied with the volume level, press the Trim Knob control or touch the *ALARM VOL:* option to close the popup menu.

Any changes made with this menu option are only temporary and revert to default settings upon patient discharge.

Minimum Alarm Volume

The Setup Display window in Monitor Defaults offers a *MIN ALARM VOLUME* setting. With this setting, you can control the minimum level to which alarm volume can be set.

For example, if you do not want alarm volume to be less than 40%, you would select 40% as the Min Alarm Volume default. The Alarm Volume popup menu would not show any volume options lower than 40%.

If you set the Alarm Volume Off option to *DISABLE* (see below) in Monitor Defaults, you MUST set a minimum alarm volume using this setting.

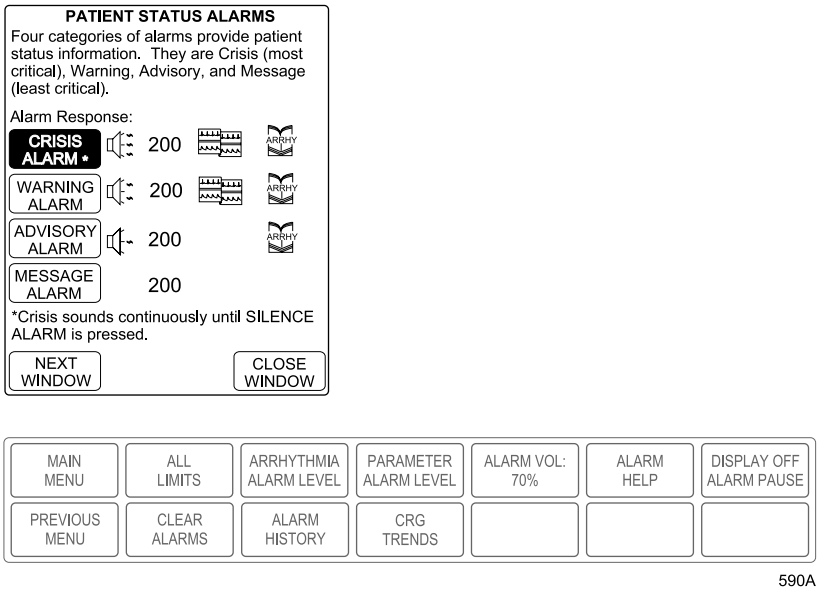
Alarm Volume Off

The Setup Display window in Monitor Defaults offers an *ALARM VOLUME OFF* setting. This default setting lets you determine whether monitor alarm volume can be turned off using the Alarm Volume popup menu. Choices are *ENABLE* and *DISABLE*. If *DISABLE* is selected as the default setting, the option *OFF* will NOT appear in the Alarm Volume popup menu.

Alarm Help

This menu option displays an information window containing alarm information.

Select *ALARM HELP* from the Alarm Control menu. An information window titled *PATIENT STATUS ALARMS* is displayed.



Alarm Help Information Window

Use the Trim Knob control or touchscreen option to navigate through the information window. To hear the tone associated with an alarm type, press the Trim Knob control when that alarm type is highlighted, or touch the alarm type.

Display Off/Alarm Pause

When you need to temporarily disconnect a patient from the monitor, you can use the Display Off/Alarm Pause option to turn off the display and pause alarms at the central station. This avoids having to discharge the patient and lose collected patient data, and prevents alarms associated with disconnecting the patient from sounding at the central station.

NOTE

Pressing the **Display On/Off** button on the keypad or remote control does not affect alarms for this monitor at the central station; they continue to be active.

Select the *DISPLAY OFF/ALARM PAUSE* option from the Alarm Control menu. A popup menu with two choices opens:

- *RETURN* — Closes the popup menu without making any changes.
- *DISPLAY OFF/ALARMS PAUSED* — Turns off the display and pauses alarms for this monitor. Alarms for this monitor are also paused at the clinical information center.

When the patient is reconnected to the monitor, simply press the **Display On/Off** button on the keypad or remote control. The display comes back on and alarms are reactivated.

Clear Alarms

This is a direct action menu option which, when selected, clears any alarm information displayed in the alarm window.

Alarm History

NOTE

This option is part of the Cardiac software package.

The Alarm History option allows you to view waveforms of stored arrhythmia and ST events for crisis, warning, and advisory alarm levels. ST references are also stored here. Refer to Chapter 10, Patient Data, for detailed information regarding the Alarm History feature.

CRG Trends

NOTE

This option is part of the High Resolution CRG Trends software package.

Selecting this option opens a high-resolution, trend window for up to three CRG Plus parameters. A new menu is also displayed with this window. Refer to Chapter 9, CRG Plus Display, for more details.

Alarm Pause

This option is only available when the **Silence Alarm** button is set to *SILENCE ONLY*. Refer to the Controlling Audio Alarms section in this chapter for more information.

When available, selecting this direct action menu option starts or stops an alarm pause. Refer to the Pausing Alarms section in this chapter.

For your notes

9 CRG Plus Display

For your notes

Parameters Displayed

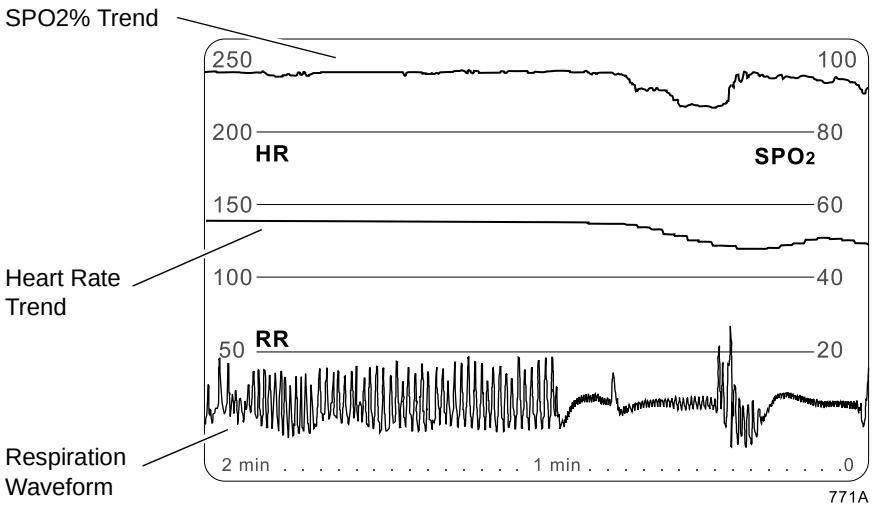
A CRG Plus display is a two-minute window on the screen that shows trends of beat-to-beat heart rate, ECG, SpO2 percentage, MAP, respiration, CO2, TcO2, and TcCO2. This display allows you to correlate changes in heart rate and breathing to oxygenation and hemodynamics. The MAP and SpO2 data is displayed only when monitoring those parameters with a Tram module.

NOTE

CRG Plus is inactive when ECG is monitored from telemetry (Combo or Rover Combo application).

The CRG Plus display format can be set to on in monitor defaults. Refer to the Monitor Defaults section in Chapter 5, Monitor Setup.

CRG Plus information can be displayed in a full mode (common scale) or individual mode (separate scales). Below is an example of the CRG Plus display portion of the monitor's screen. All parameter windows continue to be displayed, and three real-time waveforms can also be displayed — two above the CRG Plus display and one below.



CRG Plus Full Display

CRG Plus Full Display

The figure on the previous page illustrates the full display mode, which has left and right scales. Parameter labels (*HR*, *SPO2*, etc.) are displayed on the same side as the scale used for that parameter. For example, the *HR* (heart rate) label is displayed on the left side; therefore use the left scale to read the heart rate trend.

A maximum of four parameters can be displayed in the CRG Plus full display mode. Respiration and CO2 cannot be displayed simultaneously.

NOTE

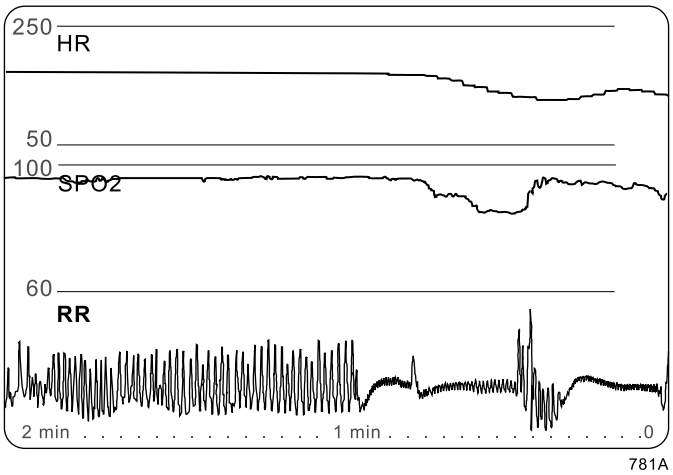
When monitoring CO2, the CO2 waveform defaults on in place of impedance respiration if the unit of measure for CO2 is mmHg. If the CO2 unit of measure is % or kPa, the impedance respiration waveform defaults on.

CRG Plus Individual Display

Below is an example of the CRG Plus individual display mode. In this mode, you can select up to five parameters for display. Three parameters were chosen in this example.

NOTE

CO2 and respiration can be displayed simultaneously in the individual mode. Because CO2 has its own scale, it can be displayed using any of its three units of measure (mmHg, %, kPa).

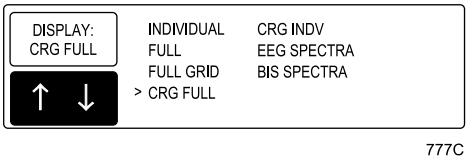


CRG Plus Individual Display

Note the time scale at the bottom of each display example. The 0 represents the current time.

Turning on the CRG Plus Display

To turn on the CRG Plus display, select *MORE MENUS* from the main display. Select *MONITOR SETUP*, then select *DISPLAY* to display the following popup menu.



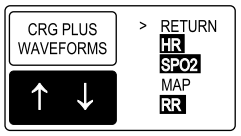
Display Mode Popup Menu

Select one of the CRG Plus choices. To turn the CRG Plus display off, select another display mode from this popup menu.

Selecting Parameters for the CRG Plus Display

To choose parameters for the CRG Plus display, follow these steps:

1. Select *MORE MENUS* from the main display.
2. Select *MONITOR SETUP*.
3. Select *WAVEFORMS ON/OFF*.
4. Select *CRG PLUS WAVEFORMS* to display the following popup menu.



CRG Plus Waveforms Popup Menu

The options displayed are determined by the parameters being monitored. The parameters that are currently appearing in the CRG Plus display are highlighted.

5. To select or deselect parameters, rotate and press the Trim Knob control or use the touchscreen arrows and *CRG PLUS WAVEFORMS* menu option.
6. Select *RETURN* to close the popup menu. Changes do not occur until the popup menu is closed.

Printing CRG Plus Parameters

Print CRG Plus

To print CRG Plus parameters, select *MORE MENUS* from the main display, then select *MONITOR SETUP*. Select *PRINT CRG PLUS* from the menu that appears. The default parameters printed are HR, SpO2, and RR (impedance respiration).

NOTE

If you are monitoring CO2, the CO2 waveform prints instead of impedance respiration, regardless of the CO2 units of measure.

The CRG Plus display does not have to appear on the screen in order to be printed.

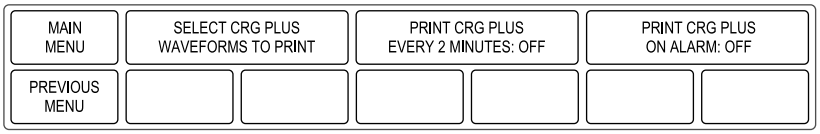
If you have a neonatal keypad or remote control, you can also use the **CRG Print** button to print the CRG Plus parameters.

CRG Plus Printing Options

You can select three CRG Plus parameters to be printed. You can also choose to have an automatic CRG Plus graph run every two minutes.

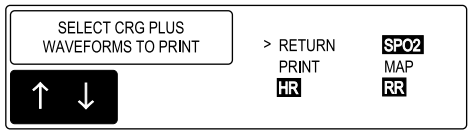
Choose Parameters

1. Select *MONITOR SETUP* from the main menu.
2. Select *GRAPH SETUP* from the Monitor Setup menu.
3. Select *CRG PLUS OPTIONS* from the Graph Setup menu. A new menu is displayed.


MAIN MENU
SELECT CRG PLUS WAVEFORMS TO PRINT
PRINT CRG PLUS EVERY 2 MINUTES: OFF
PRINT CRG PLUS ON ALARM: OFF
PREVIOUS MENU
769A

CRG Plus Options Menu

4. Select *SELECT CRG PLUS WAVEFORMS TO PRINT* to display a popup menu.



Select CRG Plus Waveforms to Print Popup Menu

5. To select (highlight) and deselect, rotate and press the Trim Knob control or use the touchscreen arrows and *SELECT CRG PLUS WAVEFORMS TO PRINT* option. The highlighted parameters will be printed.

   When selecting CRG Plus parameters for printing, Trace 1 is reserved for HR, Trace 2 is reserved for SpO2 or MAP, and Trace 3 is reserved for SpO2, MAP, RR, or CO2.

6. Select the *PRINT* option in this popup menu to print the selected CRG Plus waveforms.
7. Select *RETURN* when you have chosen the parameters for printing.

Print CRG Plus Every Two Minutes

Select the *PRINT CRG PLUS EVERY 2 MINUTES* menu option from the CRG Plus options menu to turn on/off an automatic CRG Plus graph. When on, the selected CRG Plus parameters are automatically printed every two minutes at the print window location. This continues until you turn it off.

The CRG Plus display does not have to appear on the display for the automatic print to occur.

This option and the *PRINT CRG PLUS ON ALARM* option cannot be on at the same time. The software prevents this by automatically turning one off when the other is turned on.

Print CRG Plus on Alarm

Select the *PRINT CRG PLUS ON ALARM* menu option from the CRG Plus options menu to automatically print a two-minute CRG Plus graph when an alarm occurs.

- The CRG Plus display does not have to appear on the display for CRG data to print on alarm.
- This option and the *PRINT CRG PLUS EVERY 2 MINUTES* option cannot be on at the same time. The software prevents this by automatically turning one off when the other is turned on.
- An alarm graph does not print if alarms are paused or the display is turned off.
- An alarm graph is triggered by a brady, tachy, resp apnea, MAP, or SpO2% limit violation when set at a crisis or warning alarm level. The graph is generated one minute after the violation is detected.
- The second line of the graph header indicates all parameters that were violated in the 30-second period following the alarm trigger. The lowest or highest value for violated parameters is printed (e.g., the lowest heart rate value is printed for a Brady event). The values printed represent any time within the last two minutes.
- An apnea duration time is printed only when the patient age range is set to 0-2 years. (The age range selection is made in the admit menu.)

Other Printing Information

Below is some general information to remember about all printed CRG Plus data:

- CRG Plus data always prints to the print window location.
- The last two minutes of CRG Plus data are printed.
- On the graph paper, 1 millimeter equals 1 second.
- Parameters are printed on individual scales.
  - HR prints on a scale of 50-150.
  - SpO2 prints on a scale of 60-100.
  - In Neonatal-ICU mode, MAP prints on a scale of 0-80.

    In Adult-ICU and Operating Room modes, MAP prints on a scale of 50-150.
  - CO2 prints on a scale of 0-80 or 0-10.
  - TcO2 prints on a scale of 0-750 or 0-100.
  - TcCO2 prints on a scale of 0-200 or 0-30.
- Grid paper is available for laser printers.

CRG Trends

CRG Trends is an optional feature that your institution may not have purchased.

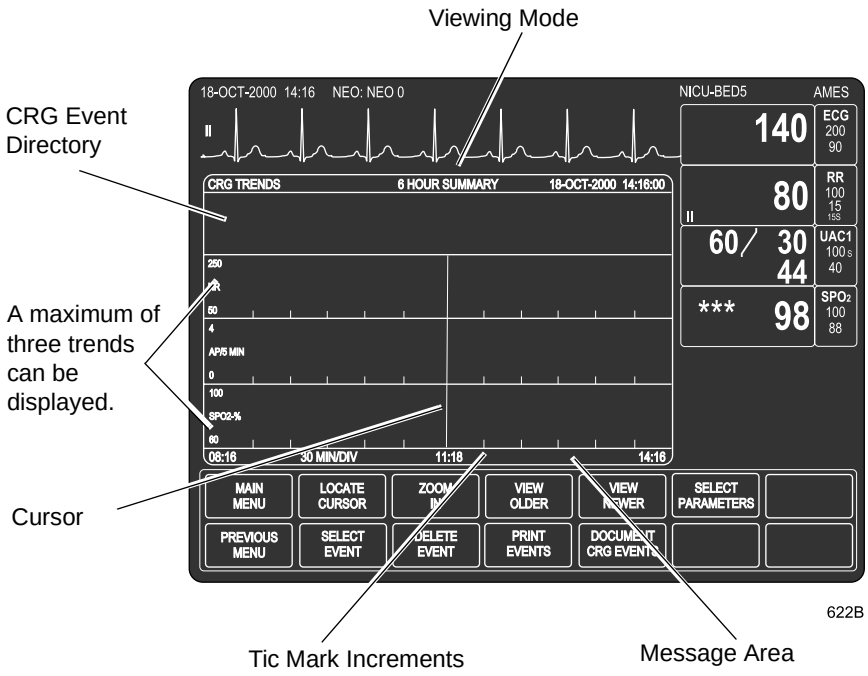
CRG Trends Display

Follow this procedure to view CRG trends:

1. Select *MORE MENUS* from the main display.
2. Select *PATIENT DATA*.
3. Select *CRG TRENDS*. The CRG Trends window and menu are displayed. The primary ECG lead continues to be displayed, as well as all of the parameter windows on the right side of the screen.

NOTE

When the system is first connected, or when admitting a new patient, there can be up to a two-minute delay before data is displayed. Data is displayed on an even minute boundary in either two-minute or six-hour segments. The display will update automatically every two minutes when the most recent data segment is currently displayed.



CRG Trends Window and Menu

This display and menu are not affected by the Menu Timeout feature in monitor defaults. They do not time out. To redisplay all waveforms and parameter windows, you must select *MAIN MENU*.

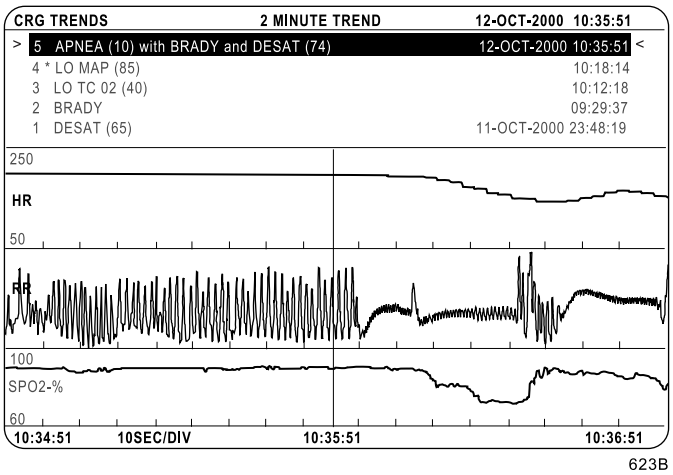
CRG Trends Event Directory

The top portion of the CRG trends window is used to display a directory of stored CRG events. A maximum of six events can be displayed in the directory. Each event has an associated number, a minimum/maximum alarm value (based on low or high alarm type) and an event start time. An asterisk (*) indicates that you cannot access the trend trace data for this event (the event may have just occurred and data may not be available yet).

When the monitor is set for Neonatal-ICU mode and an apnea, brady or desaturation alarm occurs within 30 seconds of the first alarm, the monitor groups the alarms on one text line in the event directory (refer to line 5 in the example below).

NOTE

When more than one alarm is grouped on a text line, each alarm counts as a single event. Each event can be viewed separately, and three separate events are recorded in the event directory.



CRG Trends Window with Event Directory

For alarms to be stored in the event directory, alarms must be resolved (patient condition has returned to within set limits) and have an alarm level greater than message. The CRG trends directory is automatically updated when a valid alarm is resolved. The directory can hold up to 100 events. Once the directory is full, and a new event occurs, the oldest event in the directory is removed and the new event is added. However, the trend traces are only stored for 24 hours. Therefore, it is possible to have events stored in the directory for which traces are no longer available.

All events in the event directory may be selected. Once an event is selected, a 2-minute trend of the event is displayed in the trace area with the event time centered.

CRG Trends Menu Options

Locate Cursor

The *LOCATE CURSOR* option allows you to move the vertical cursor to a specific time. The parameter values at the position of the cursor are then displayed.

Zoom In/Out

The *ZOOM IN* and *ZOOM OUT* options allow you zoom in to a specified two-minute trend from any six-hour summary or zoom out to a specified six-hour summary from any two-minute trend. The cursor centers to the selected time associated with the displayed trace.

View Older/View Newer

The *VIEW OLDER/VIEW NEWER* options allow you to view older and newer data.

Select Parameters

The *SELECT PARAMETERS* option opens a popup menu to select CRG parameters to be displayed as trends. Your choices are *HR*, *SPO_2*, *MAP*, *RESP*, *CO_2*, *TC O_2*, and *TC CO_2*.

NOTE

The CO2 two minute waveform is not available when using the TC module with the combo sensor.

Respiration Trend

The data for the respiration trend is as follows:

- Six-hour display
  - In Neonatal-ICU mode it is apnea per 5 minutes. This prints as apnea per 1 minute.
  - In Adult-ICU and Operating Room modes, it is the respiration rate.
- Two-minute display
  - In all modes it is the respiration waveform.

Select Event

This option opens a popup menu that allows you to select a specific CRG event from the event directory. All events in the event directory may be selected. Once an event is selected, a 2-minute trend of the event is displayed in the trace area with the event time centered.

Delete Event

Events older than 24 hours and individual events with associated traces can be permanently deleted using this option.

Selecting the *DELETE EVENT* option opens a popup menu with the following options:

- *NO* — Returns to the CRG Trends menu.
- *YES* — Deletes the event selected (highlighted) in the event directory.
- *>24 HRS* — Deletes all events older than 24 hours and that no longer have CRG trend traces associated with them.

Print Events

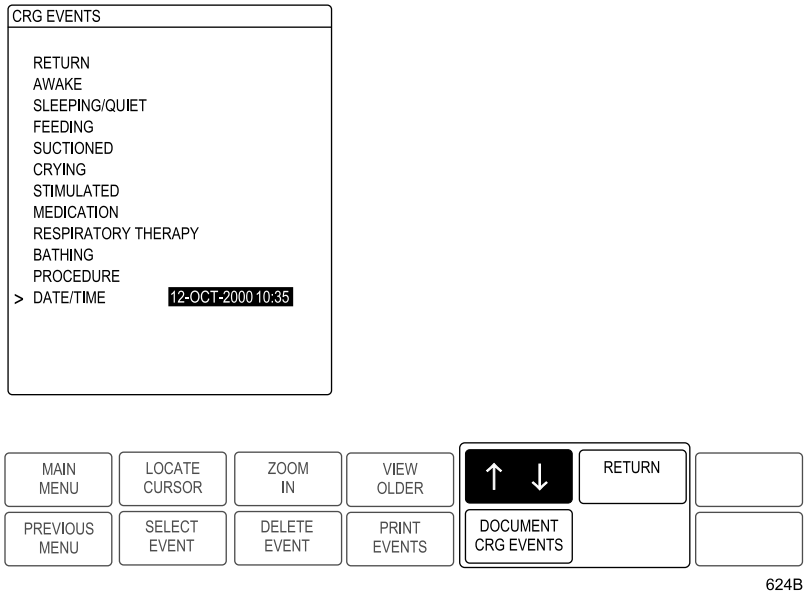
Use this option to print all available event entries in the event directory. Events are graphed at the print window location.

Document CRG Events

The Document CRG Events feature is only available in Neonatal-ICU mode when the patient is admitted to the monitor. This option provides a list of events associated with the patient's condition at a specific time. These events can be edited, selected and stored in the event directory.

To access the Document CRG Events information window, follow this procedure:

1. Select *MORE MENUS* from the main display.
2. Select *PATIENT DATA*.
3. Select *DOCUMENT CRG EVENTS* to display the following information window and popup menu.



Document CRG Events Popup Menu and Information Window

To edit events in the Document CRG Events information window, follow this procedure:

1. Move the pointer (>) in front of the *DATE/TIME* selection.
2. Highlight the date/time selection (see figure) by pressing the Trim Knob control or touching the *DOCUMENT CRG EVENTS* option.
3. Scroll to a specific time. Press the Trim Knob control or touch the *DOCUMENT CRG EVENTS* option when the specific time you want to edit appears.
4. Move the pointer to an event, then press the Trim Knob control or touch the *DOCUMENT CRG EVENTS* option to document that event. Your selection will then appear in the CRG Trends directory.
5. Select *RETURN* when all changes are completed. The popup menu and information window close.

Troubleshooting

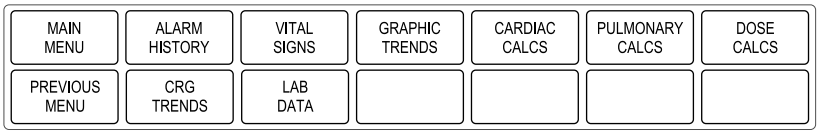
Problem:	*Solution:*
Impedance respiration waveform is too small or too large for the CRG Plus display.	In the Respiration menu, use either the *RELEARN RESPIRATION* option or the *AUTO SIZE* option.

10 Patient Data

For your notes

Patient Data Menu

Select *PATIENT DATA* from the main menu to display the Patient Data menu.



Patient Data Menu

- *ALARM HISTORY* — Displays stored arrhythmia alarm events, ST references, and ST alarm levels. (Cardiac software package only.)
- *VITAL SIGNS (TABULAR TRENDS)* — Displays the values for the patient's monitored parameters over the last 24 hours.
- *GRAPHIC TRENDS* — Plots trends for selected parameters.
- *CARDIAC CALCS* — Enters the cardiac calculations program. (Cardiopulmonary software package only.)
- *PULMONARY CALCS* — Enters the pulmonary calculations program. (Cardiopulmonary software package only.)
- *DOSE CALCS* — Enters the dose calculations program.
- *CRG TRENDS* — Displays high-resolution CRG trends. (High Resolution CRG Trends software package only.)
- *LAB DATA* — Accesses laboratory data for this patient from your hospital's lab information system (LIS). A Solar Lab Access Server with an interface to the LIS is necessary for this feature to function.

Detailed information on each option is found in this chapter.

Alarm History

NOTE

This option is part of the Cardiac software package.

The Alarm History option allows you to view waveforms of stored arrhythmia and ST events for crisis, warning, and advisory alarm levels. ST references are also stored here.

In Adult-ICU and Neonatal-ICU modes, events are not stored in Alarm History during an alarm pause or if the monitor is in a discharged state.

To view alarm histories, select the *ALARM HISTORY* option from the Patient Data menu or the Alarm Control menu. A popup menu and information window are displayed.

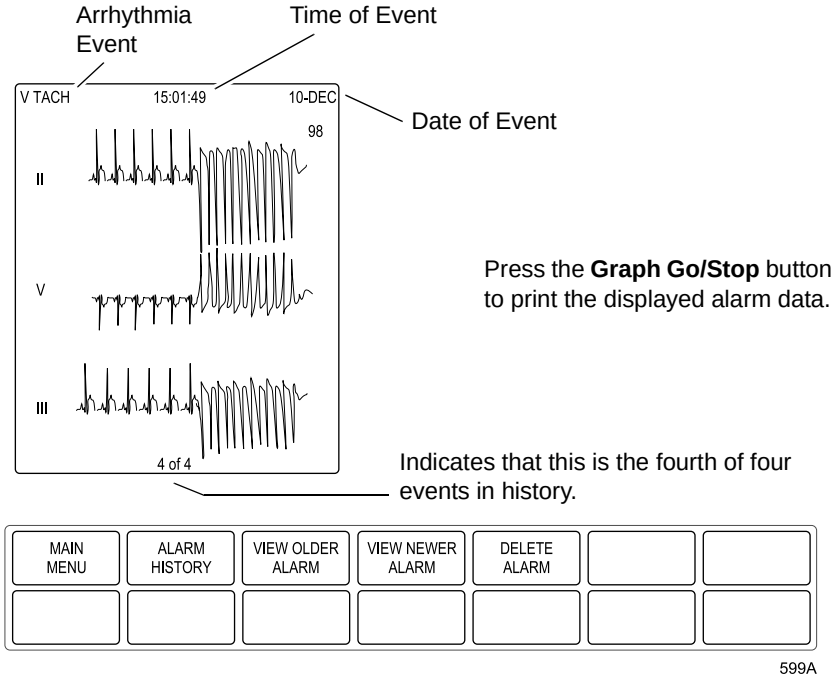
The information window displays arrhythmia and ST events classified as crisis, warning, and advisory, in chronological order beginning with the most recent event. A maximum of 36 arrhythmia events and 10 ST events (including references) can be stored. Up to 15 events can be displayed at one time.

The pointer in the information window points to the most recent event. If you want to view the waveform data for that event, press the Trim Knob control or touch the *ALARM HISTORY* option. If you want to view the waveform data for another event on the list, select a different event.

Select *RETURN* if you do not wish to view any events. The information window closes and the Patient Data menu (or Alarm Control menu) is displayed.

Select Alarm

To select an alarm to view, press the Trim Knob control (or touch the Alarm History option) when the pointer is in front of the event you wish to view. The applicable waveforms appear in the information window, and a new menu appears in the menu area. The example below is an arrhythmia event. Refer to the next page for ST event information.



Select Alarm (Arrhythmia Event) Information Window and Menu

For arrhythmia events, three leads of ECG are displayed. If an ART line was being monitored at the time the arrhythmia occurred, two leads of ECG and the ART waveform are displayed. Associated numerics are also included. Ten seconds of data are presented in a compressed format, which prints at 25 mm/sec.

NOTE

When monitoring from telemetry, events are stored in the telemetry system. The last 36 events are viewable from the monitor.

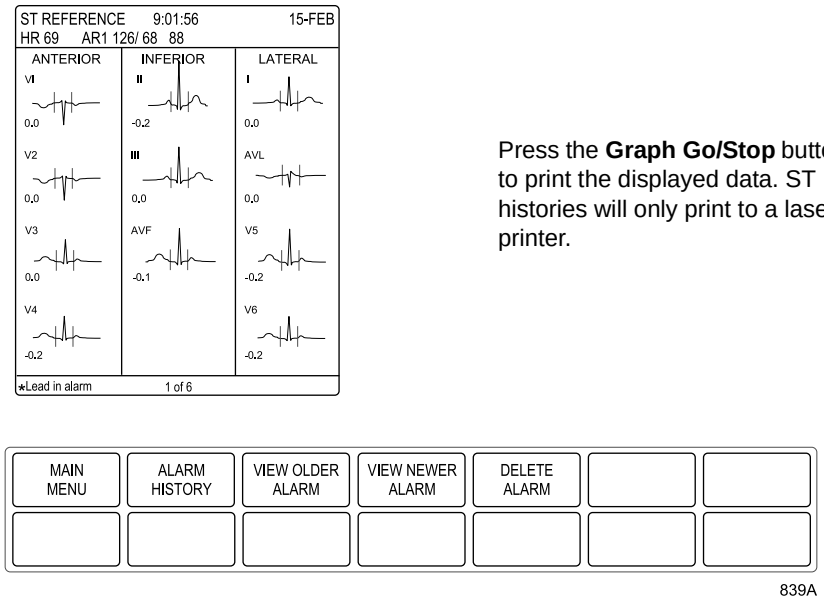
NOTE

Waveforms from a separate BP module (i.e., other than the Tram module) cannot be stored in history.

The Select Alarm menu options are:

- *VIEW OLDER ALARM* — Displays the next older event, if any, stored in alarm history.
- *VIEW NEWER ALARM* — Displays the next newer event, if any, stored in alarm history.
- *DELETE ALARM* — Opens a popup menu with Yes and No options. Select *YES* to delete the displayed event.
- *ALARM HISTORY* — Returns to the chronological list of arrhythmia events.

If you select an ST alarm event or an ST reference, the information window looks similar to the following:



Press the **Graph Go/Stop** button to print the displayed data. ST histories will only print to a laser printer.

Select Alarm (ST Reference) Information Window and Menu

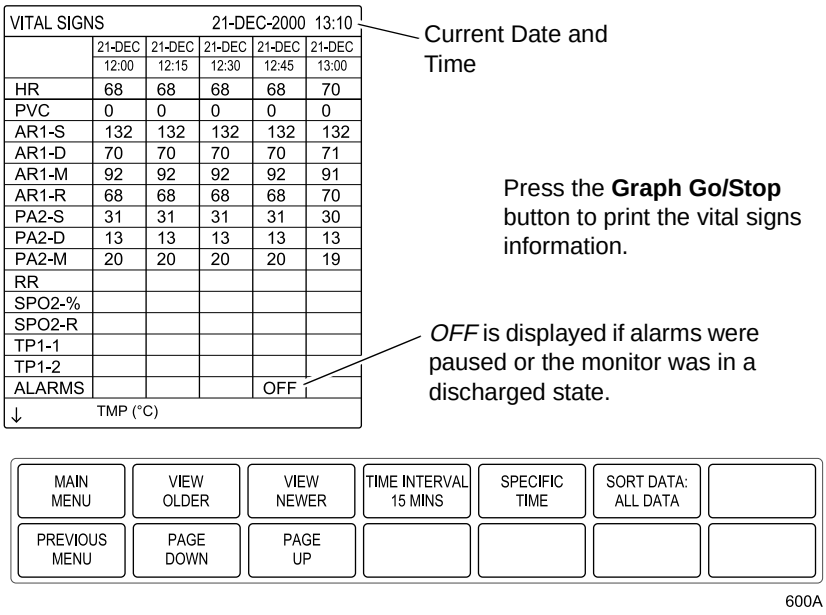
A QRS complex of all available leads (with the exception of AVR) is displayed. If viewing an ST alarm event, an asterisk is displayed next to each lead label that is in violation of the set ST limits.

Vital Signs

NOTE

Vital Signs is called *TABULAR TRENDS* in the Operating Room mode.

Upon admission to the system, a history of the patient's vital signs is continuously collected. To display this data, select *VITAL SIGNS* (*TABULAR TRENDS*) from the Patient Data menu. An information window and a new menu are displayed.



Vital Signs Menu and Information Window

Twenty-four hours of parameter data are stored, except for cardiac calculations and pulmonary calculations. The last 20 cardiac calculations and the last 10 pulmonary calculations are stored.

NOTE

When monitoring two SPO2 sites, SPO2 data from the Solar SPO2 module is identified in vital signs as *SPO2M*.

You cannot change any values in Vital Signs, but you can use the menu options to move through the collected data. The menu options are described in the following sections.

View Older/View Newer

Each of these direct action menu options moves the displayed data either backward or forward in time, if data is available.

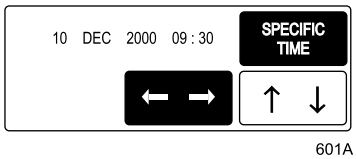
Time Interval

Select *TIME INTERVAL* to choose the time interval between the displayed columns of data. This does not affect data collection, only how the data is displayed.

The time interval options are *1 HR, 30 MINS, 15 MINS, 5 MINS,* and *1 MIN*.

Specific Time

Select the *SPECIFIC TIME* option to open a popup menu that allows you to enter a specific time you wish to find and display in Vital Signs.



Specific Time Popup Menu

1. Rotate the Trim Knob control or use the touchscreen arrows to move the highlight onto the date and time. (The popup menu opens showing the current date and time.)
2. Press the Trim Knob control when an element of the date or time is highlighted.

   NOTE

   This step is not necessary when using the touchscreen feature.

3. Rotate the Trim Knob control or use the touchscreen arrows to make a change. Press the Trim Knob control to complete the change (not necessary when using the touchscreen).
4. Repeat this procedure for the other elements of the date and time.
5. When finished, close the popup menu. The specific time you requested (or the time closest to it if your time interval is set for other than one minute) appears in the middle column of the information window.

Sort Data

Selecting the *SORT DATA* menu option allows you to sort the data to display the collected data for an episodic parameter. The options available in the popup menu are: *ALL DATA, NBP, GAS, RM, CARD CALC, PULM CALC, POC,* and *VENT*. Selecting *ALL DATA* redisplays all collected data.

Page Up/Page Down

These direct action menu options can be used to display any additional data not displayed on the screen due to space limitations. Page Down moves down to the next page of data; Page Up moves back up.

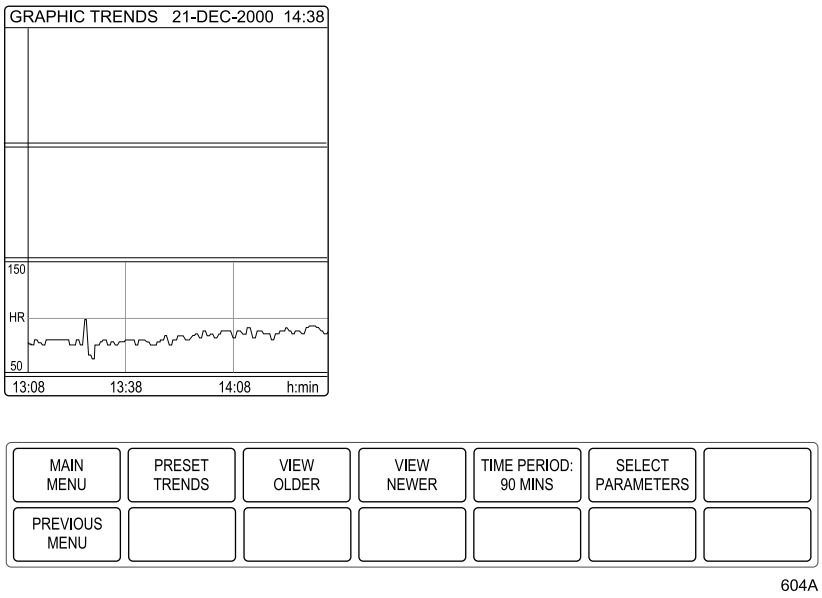
Graphic Trends

Collected patient data can be displayed through trends. A trend is a graphic representation of one parameter over a specified period of time.

Every non-episodic parameter is sampled 30 times a minute. A median value is determined from those samples, and that value is stored for trend display at one-minute resolution.

Episodic parameters (NBP, etc.) are stored every time one occurs.

To view graphic trends, select *GRAPHIC TRENDS* from the Patient Data menu. An information window and a new set of menu options are displayed.



Graphic Trends Menu and Information Window

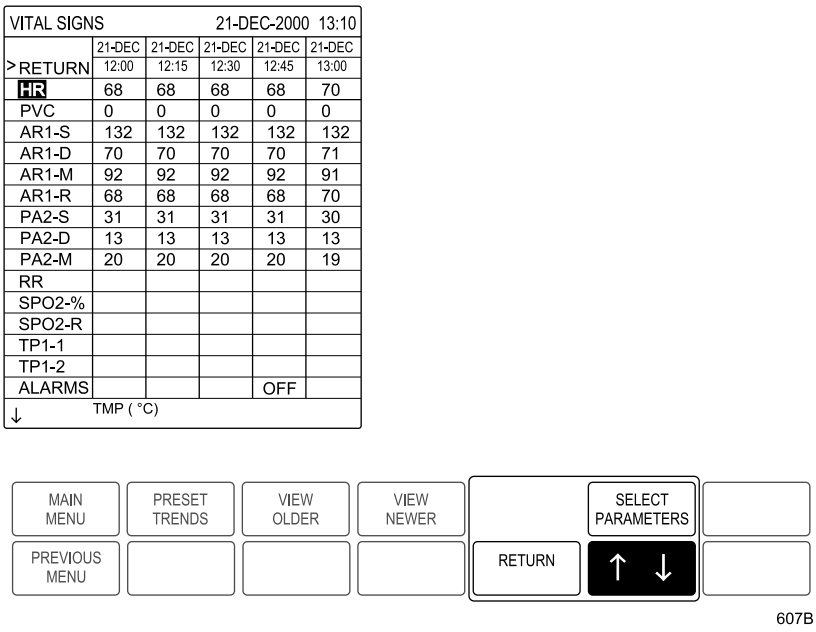
The Graphic Trends for the last selected parameters are displayed. Heart rate is the default if none were previously selected.

The trend data automatically updates while it is being displayed. Refer to the Time Period section in this chapter.

Press the **Graph Go/Stop** button to print the displayed trends.

Select Parameters

To select parameters for graphic trends, choose the *SELECT PARAMETERS* option from the Graphic Trends menu. A popup menu and the Vital Signs information window are displayed.



VITAL SIGNS 21-DEC-2000 13:10

	21-DEC 12:00	21-DEC 12:15	21-DEC 12:30	21-DEC 12:45	21-DEC 13:00
>RETURN					
HR	68	68	68	68	70
PVC	0	0	0	0	0
AR1-S	132	132	132	132	132
AR1-D	70	70	70	70	71
AR1-M	92	92	92	92	91
AR1-R	68	68	68	68	70
PA2-S	31	31	31	31	30
PA2-D	13	13	13	13	13
PA2-M	20	20	20	20	19
RR					
SPO2-%					
SPO2-R					
TP1-1					
TP1-2					
ALARMS				OFF	

↓ TMP (°C)

Select Parameters Popup Menu and Information Window

To mark a parameter for displaying or plotting, select it with the Trim Knob control or touchscreen. In the above example, *HR* is highlighted because it is the default. Up to three parameters can be selected. Selected a fourth will unmark the first parameter chosen.

NOTE

NBP or an invasive pressure with a systolic, diastolic, and mean value is considered one selection. For example, if you select *AR1-S*, the other two parameters (*AR1-D* and *AR1-M*) will also highlight. However, the trends for all three of these parameters appear only in one trend window. If you only want to plot one of the three pressure parameters, simply unmark the unwanted ones. This is also true for inspired and expired CO2 and gas parameters.

When the parameters you wish to plot as trends are all highlighted, select *RETURN*. The popup menu closes and the information reconfigures to display the selected trends.

Preset Trends

The Preset Trends menu option can be useful as a shortcut in plotting trends. When you select *PRESET TRENDS* from the Graphic Trends menu, a popup menu with preset combinations of parameters for trending opens. The choices available vary with the patient-monitor type for which your monitor is set.

Select a parameter combination if one suits your needs. The information window immediately displays the parameters as graphic trends. Select *RETURN* to close the popup menu.

View Older/View Newer

Use these options to move backward and forward in time.

NOTE

These options do not function when viewing in the 6-minute time period.

Time Period

Use this option to open a popup menu used to select a time period for viewing the selected trends. Options are: *24 HRS*, *12 HRS*, *6 HRS*, *3 HRS*, *90 MINS*, *45 MINS*, *30 MINS*, *15 MINS*, and *6 MINS*.

Displayed trends update automatically. The frequency of the update is depends on the time period selected:

- *6 MINS* updates every 10 seconds.
- *15*, *30*, *45*, and *90 MINS* update every minute.
- *3* and *6 HRS* update every minute.
- *12 HRS* updates every two minutes.
- *24 HRS* updates every four minutes.

Cardiac Calcs

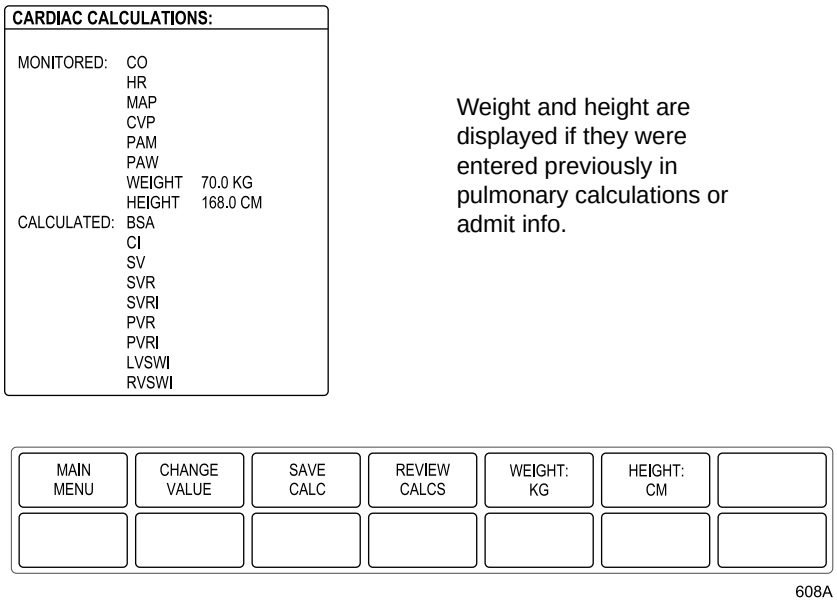
NOTE

This option is part of the Cardiopulmonary software package.

The cardiac calculations program is an integral part of the cardiac output function of the monitor. Refer to Chapter 15, Cardiac Output, for details on how to use the cardiac calculations program with cardiac output.

Having cardiac calculations available in the Patient Data menu allows you to use the cardiac calculations program if you are doing cardiac output measurements with a device other than the monitor.

Select *CARDIAC CALCS* from the Patient Data menu. The cardiac calculations menu and information window are displayed.



Cardiac Calcs Menu and Information Window

NOTE

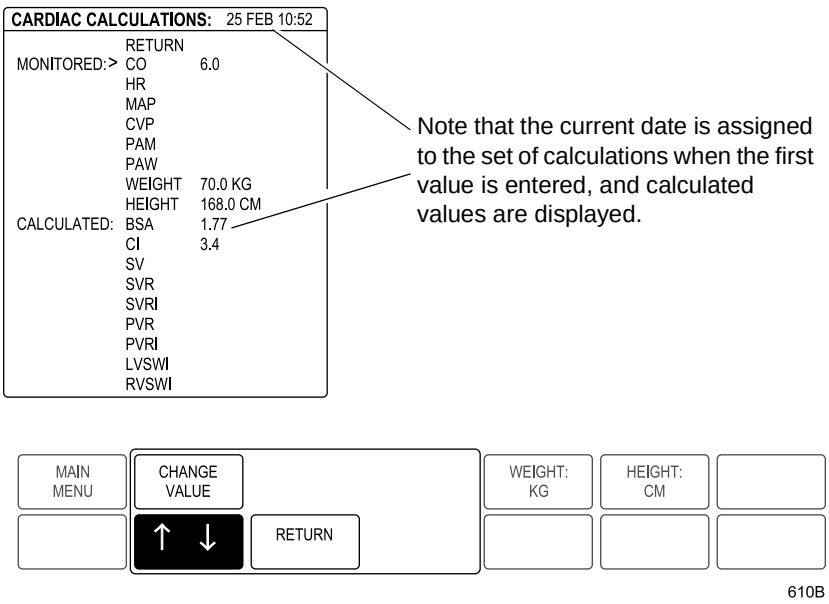
If a set of calculations is displayed, the last set of calculations was never saved. A date and time is displayed at the top of the information window. Use the *SAVE CALC* option to save the set to Vital Signs.

Change Value

Select *CHANGE VALUE* from the Cardiac Calcs menu to enter or changed monitored values in the information window. A popup menu opens and the pointer and *RETURN* option are displayed at the top of the information window.

Rotate the Trim Knob control or use the touchscreen arrows to move the pointer in front of *CO*. Press the Trim Knob control once or touch the *CHANGE VALUE* option. A default value of *6.0* is displayed.

Rotate the Trim Knob control to change the value, then press it to enter the value and display the calculated values. Or, use the touchscreen arrows to change the value, then touch the *RETURN* option in the popup menu to enter the value and display the calculated values.

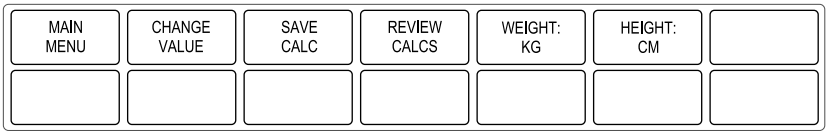


Cardiac Output Value Entered

Enter other values in the same manner as above. When all desired values are entered, select *RETURN* to close the popup menu.

CARDIAC CALCULATIONS:		25 FEB 10:52
MONITORED:	CO	6.0
	HR	69
	MAP	94
	CVP	10
	PAM	23
	PAW	10
	WEIGHT	70.0 KG
	HEIGHT	168.0 CM
CALCULATED:	BSA	1.79
	CI	3.3
	SV	87.0
	SVR	1119
	SVRI	1980
	PVR	173
	PVRI	306
	LVSWI	56.1
	RVSWI	8.7

Press the **Graph Go/Stop** button to print the displayed calculations.



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Completed Set of Cardiac Calculations

Save Calc

Select the *SAVE CALC* option from the Cardiac Calcs menu to save the displayed values to Vital Signs. The message "*SAVE OPERATION COMPLETE*" appears in the message line. If the message "*SAVE OPERATION FAILED*" appears, a CO value has not been entered, you already saved this set of calculations, or the ECG source module is not in the housing.

Review Calcs

To review all saved calculations, select the *REVIEW CALCS* option. The Vital Signs information window is displayed. The data is sorted so cardiac calculations appear first in the list.

Since you have entered the vital signs program, the Vital Signs menu options are displayed. However, when sorted for cardiac calcs, the Time Interval and Specific Time options are non-functional. Refer to the Vital Signs section in this chapter for more information.

Weight and Height

The Weight and Height options in the Cardiac Calcs menu allow you to switch the units of measure between kilograms and pounds for weight, and centimeters and inches for height. These are direct action menu options.

Pulmonary Calcs

NOTE

This option is part of the Cardiopulmonary software package.

All aspects of oxygen uptake, transport, and delivery are necessary in the assessment of the critically ill patient. These parameters cannot be directly measured, but are derived from monitored cardiopulmonary variables.

Monitored/Measured Parameters

The monitored values are measured data from arterial blood gases and monitored ventilator parameters. These values are entered manually and then used to derive pulmonary calculations. The chart below shows the monitored/measured parameters, the labels used to identify these, and the units of measure.

Monitored/Measured Parameters

Parameter	Label	Unit
Weight	WEIGHT	kg or lbs.
Height	HEIGHT	cm or inches
Fractional inspired oxygen	FiO2	%
Positive end expiratory pressure	PEEP	cmH2O
Respiration rate	RR	bpm
Tidal volume	TV	mL
End inspiratory pressure	PIP	cmH2O
Cardiac output	CO	L/min
Barometric pressure	PBAR	mmHg
Hemoglobin	Hb	gm/100ml
Partial pressure of CO2 in arterial blood	PaCO2	mmHg
Partial pressure of O2 in arterial blood	PaO2	mmHg
Arterial oxygen saturation	SaO2	%
Partial pressure of O2 in mixed venous	PvO2	mmHg
Mixed venous oxygen saturation	SvO2	%

Derived Pulmonary Calculations

The derived pulmonary calculation values are figured automatically. The chart below shows the derived pulmonary calculations, the labels used to identify these on the screen, the units of measure, and the formulas used.

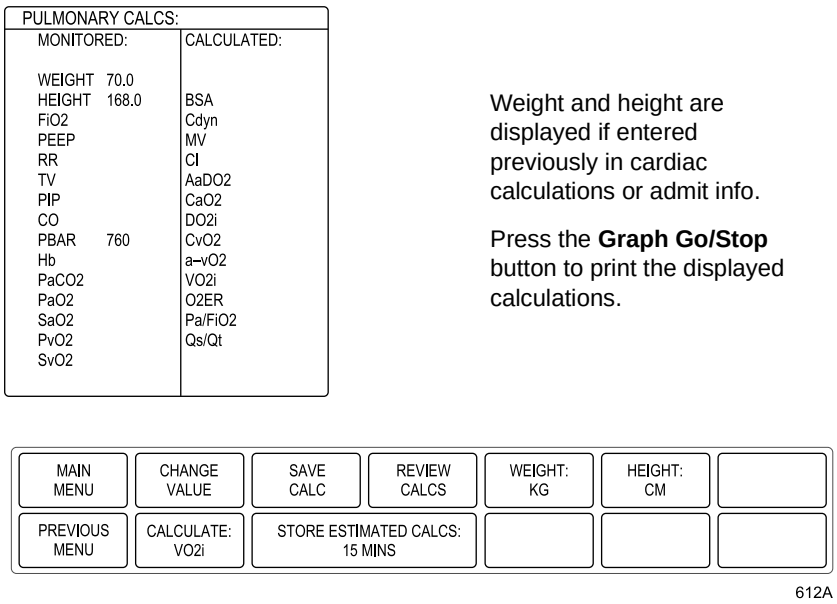
Derived Pulmonary Calculations

Parameter	Label	Unit	Formula
Body surface area	BSA	m^2	$HT^{0.725} \times WT^{0.425} \times 0.007184$
Dynamic compliance	Cdyn	mL/cmH_2O	$\frac{TV}{PIP - PEEP}$
Minute volume	MV	L/min	$\frac{TV \times RR}{1000}$
Cardiac index	CI	$L/min/m^2$	$\frac{CO}{BSA}$
Alveolar arterial oxygen gradient	$AaDO_2$	mmHg	$PAO_2 - PaO_2$
Arterial oxygen content	CaO_2	mL/100 mL	$\left(Hb \times 1.39 \times \frac{SaO_2}{100}\right) + (PaO_2 \times 0.0031)$
Oxygen delivery index	DO_2I	$mL/min/m^2$	$CaO_2 \times CI \times 10$
Mixed venous oxygen content	CvO_2	mL/100 mL	$\left(Hb \times 1.39 \times \frac{SvO_2}{100}\right) + (PvO_2 \times 0.0031)$
Arterial venous oxygen content difference	$a–vO_2$	mL/100 mL	$CaO_2 - CvO_2$
Oxygen consumption index	VO_2I	$mL/min/m^2$	$a–vO_2 \times CI \times 10$
Fick cardiac output	FICK CO	L/min	$\frac{VO_2I \times BSA}{(CaO_2 - CvO_2) \times 10}$
Oxygen extraction ratio	O_2ER	%	$\frac{(CaO_2 - CvO_2) \times 100}{CaO_2}$
Oxygenation ratio	Pa/FiO_2	%	$\frac{PaO_2}{\frac{FiO_2}{100} \times 100}$
Shunt fraction	Qs/Qt	%	$\frac{\left[\left[Hb \times 1.39 \times \left(1 - \frac{SaO_2}{100}\right)\right] + [0.0031 \times (PAO_2 - PaO_2)]\right] \times 100}{\left[Hb \times 1.39 \times \left(1 - \frac{SvO_2}{100}\right)\right] + [0.0031 \times (PAO_2 - PvO_2)]}$
Alveolar pressure	PAO_2*	mmHg	$\left[\frac{FiO_2}{100} \times (PBAR - 47)\right] - \left(\frac{PaCO_2}{0.8}\right)$

* PAO_2 does not appear in the pulmonary calculations display, but it is used to derive $AaDO_2$.

References:
1 Chatburn, Robert and Lough, Marvin: Handbook of Respiratory Care. Year Book Medical Publishers, Inc., Chicago, 1990.
2 Marino, Paul: The ICU Book. Williams & Wilkin, Baltimore, 1998.
3 Tobin, Martin: Principles & Practice of Intensive Care Monitoring, McGraw-Hill, Inc., 1998.

To use the pulmonary calculations program, select *PULMONARY CALCS* from the Patient Data menu. An information window and a new menu are displayed.



Pulmonary Calcs Menu and Information Window

If a set of calculations was previously saved, many of the values will be displayed without a date and time. This is intended to speed entry of another set of calculations, since only some of the parameters are usually affected. A date and time are displayed when the first change is made.

If a date and time are displayed with the values, it means that the last set of calculations was never saved. Use the *SAVE CALC* option to save the set to vital signs. Exit the program using the Main Menu option, then reenter. This must be done to clear the date and time from the calculation.

Change Value

Select *CHANGE VALUE* from the Pulmonary Calcs menu to enter or changed monitored values in the information window. A popup menu opens and the pointer and *RETURN* option are displayed at the top of the information window.

Move the pointer to the parameter you want to enter or change. Press the Trim Knob control once, or touch the *CHANGE VALUE* option. If no previous value is displayed, a default value is displayed.

Rotate the Trim Knob control or use the touchscreen arrows to change the value. Press the Trim Knob control or touch the *CHANGE VALUE* option to enter the value. Calculated values are displayed as the data used to obtain them is entered.

Select *RETURN* when all desired values are entered. The popup menu closes and the Return option clears from the information window.

Save Calc

Select the *SAVE CALC* option from the Pulmonary Calcs menu to save the displayed values to vital signs. The message "*SAVE OPERATION COMPLETE*" appears in the message line. If the message "*SAVE OPERATION FAILED*" appears, it indicates that you already saved this set of calculations, or that the ECG source module is not in the housing.

Review Calcs

To review all saved calculations, select the *REVIEW CALCS* option. The Vital Signs information window is displayed. The data is sorted so pulmonary calculations appear first in the list.

Since you have entered the vital signs program, the Vital Signs menu options are displayed. However, when sorted for pulmonary calcs, the Time Interval and Specific Time options are non-functional. Refer to the Vital Signs section in this chapter for more information.

Weight and Height

The Weight and Height options in the Pulmonary Calcs menu allow you to switch the units of measure between kilograms and pounds for weight, and centimeters and inches for height. These are direct action menu options.

Calculate

This direct action menu option switches between calculating *VO2i* or *FICK CO*. If *CALCULATE: VO2i* is selected, you enter a CO value in the "monitored" column. If *CALCULATE: FICK CO* is selected, you enter an VO2i value in the "monitored" column.

Store Estimated Calcs

This menu option directs the monitor to obtain some estimated pulmonary calculations at a specified time interval and store them in vital signs. This option defaults on at 15-minute intervals.

These estimated calculations can only be obtained when SpO2 and/or SvO2 are monitored by GE Medical Systems *Information Technologies* modules, and a hemoglobin value is entered. Estimated values are obtained for a 12-hour period following a hemoglobin entry and are stored in vital signs with all data. (Refer to the Sort Data section in this chapter.)

The following chart shows what is estimated, the label used to identify it, and the formula used. An "*e*" preceding a label indicates that it is an estimated value.

Estimated Calculations Stored in Vital Signs

Estimated Parameter	Label	Formula	Necessary Data
Arterial oxygen content	$eCaO_2$	$(Hb \times 1.39) \times \frac{SpO_2}{100}$	SpO_2, Hb
Mixed venous oxygen content	$eCvO_2$	$(Hb \times 1.39) \times \frac{SvO_2}{100}$	SvO_2, Hb
Arterial venous oxygen content difference	$ea–vO_2$	$eCaO_2 – eCvO_2$	SpO_2, SvO_2, Hb
Shunt fraction	eQs/Qt	$\frac{(Hb \times 1.39) \times \left(1 - \frac{SpO_2}{100}\right) \times 100}{(Hb \times 1.39) \times \left(1 - \frac{SvO_2}{100}\right)}$	SpO_2, SvO_2, Hb
Oxygen extraction ratio	eO_2ER	$\frac{eCaO_2 - eCvO_2}{eCaO_2} \times 100$	SpO_2, SvO_2, Hb
Oxygen delivery index	eDO_2I	$eCaO_2$ x CI x 10	SpO_2, Hb, CO
Oxygen consumption index	eVO_2I	$ea–vO_2$ x CI x 10	SpO_2, SvO_2, Hb, CO

The eDO_2I and eVO_2I values are automatically included in cardiac calculations with each cardiac output, regardless of whether the Store Estimated Calcs option is on or off.

If you want to turn this software feature off or change the storage time interval, select the *STORE ESTIMATED CALCS* option from the Pulmonary Calcs menu. A popup menu with the options *OFF*, *1 HR*, *30 MINS*, and *15 MINS* opens. Make your selection using the Trim Knob control or touchscreen and close the popup menu.

Dose Calcs

The intravenous administration of medications is a common practice. Many drugs are titrated based on the patient's physiologic response to the medication. Accuracy and safety are always important in drug therapy, and precise control of drug administration is essential. The dose calculations feature is important because it provides an accurate and safe method of determining drug dosage, as well as the precision control that is essential.

An order for a medication is either written by the physician or is a standing protocol in the unit based on the patient's condition. The order will specify the drug and the dose to be administered. The nurse and/or pharmacy will mix the drug in solution, and then determine how fast to administer the drug in order to deliver the proper drug dosage.

Neonates present a different approach to drug administration because the amount of fluid to be administered is vital. Usually, the drug dosage is ordered and the flow rate in cc/hr is prescribed. The nurse must determine the amount of drug to place in the solution in order to meet the rate/dose combination.

In other cases, the physician may order a drug dosage to be infused over a period of time. The amount of drug in solution may or may not be specified. In this situation, the nurse must determine the rate that is needed to infuse the drug over the period of time ordered.

Still another situation occurs in cases where drugs are administered to resuscitate the patient, and then the dose is determined after the response. The nurse will take the solution and drug quantities and the rate of the infusion to determine the dose that the patient is actually receiving.

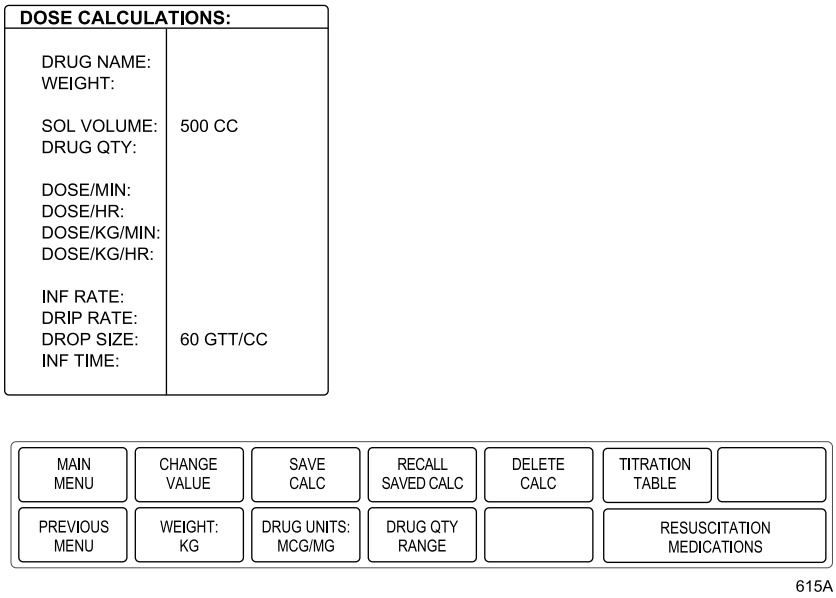
The dose calculations program can be used in all of the above situations. In addition, it also provides a titration table that can be used as the drugs are titrated, based on the patient's physiologic response.

The dose calculations program has a library of commonly used drugs. The drug libraries for the different monitor modes are:

Common Drugs	Adult-ICU mode and Operating Room mode	Neonatal-ICU mode
Aminophylline	X	X
Dobutamine	X	X
Dopamine	X	X
Epinephrine	X	X
Fentanyl		X
Heparin	X	X
Inocor	X	X
Insulin	X	X
Isuprel	X	
Lidocaine	X	
Midazolam		X
Morphine		X
Neosynephrine	X	X
Nipride	X	
Nitroglycerin	X	
Norepinephrine	X	
Pitocin	X	
Procainamide	X	
Prostaglandin E		X
Tolazoline		X
Vasopressin	X	
Drug A	X	X
Drug B	X	X
Drug C	X	X
Drug D	X	X

Drug A through Drug D are used for drugs not specified in the library.

To enter the dose calculations program, select *DOSE CALCS* from the Patient Data menu. An information window and a new set of menu options are displayed.



Dose Calcs Menu and Information Window

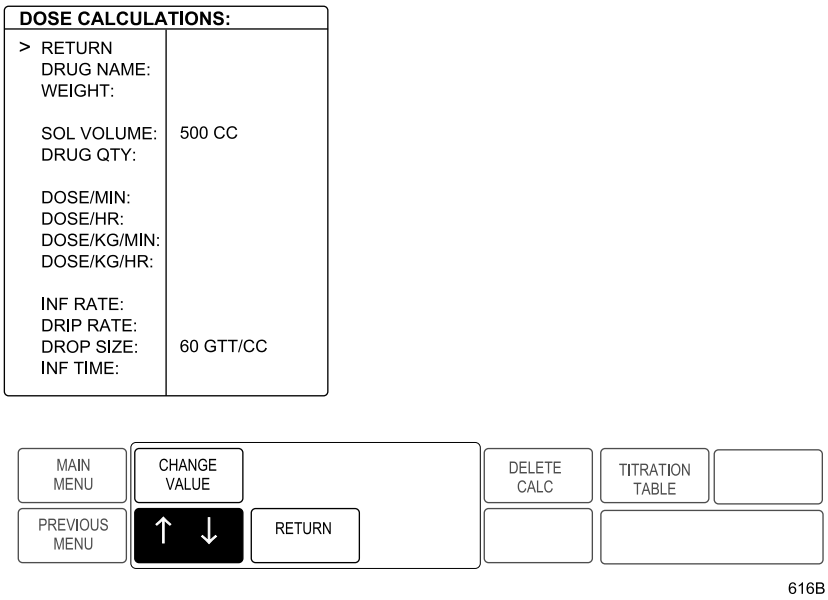
- *CHANGE VALUE* — Used to enter or change values in the information window.
- *SAVE CALC* — Saves the set of calculations. Up to four sets can be saved, but only one set for each drug.
- *RECALL SAVED CALC* — Opens a popup menu to select a set of saved calculations for display.
- *DELETE CALC* — Opens a popup menu to choose one or more sets to delete.
- *TITRATION TABLE* — Opens a popup menu and a new information window displaying a titration table for the drug.
- *WEIGHT* — Changes the units of measure for the patient's weight.
- *DRUG UNITS* — Switches the drug units between grams and units (for use with drugs labeled A, B, C, or D).

- *DRUG QTY RANGE* — Selects a range for quicker entry of a drug quantity value when using a drug unknown to the system (for use with drugs labeled A, B, C, or D).
- *RESUSCITATION MEDICATIONS* — This option appears only when the monitor is set for Neonatal-ICU mode. Selecting it opens an information window that provides information about neonatal resusciation medications and dosages.

Change Value

This option allows you to enter values in the information window. With this option, enter a drug name first.

1. Select the *CHANGE VALUE* option from the Dose Calcs menu. A popup menu opens and a pointer and *RETURN* option are displayed at the top of the information window.



Change Value Popup Menu and Information Window

2. Move the pointer to *DRUG NAME*.
3. Press the Trim Knob control or touch the *CHANGE VALUE* option. The first name in the drug library is displayed.
4. Scroll through the library names. When the drug name you want is displayed, press the Trim Knob control or touch *CHANGE VALUE* to select it.

NOTE

If you are using a drug that is not in the list, choose *DRUG A, B, C,* or *D* as its label. Make a note of the drug name you assign to A, B, C or D.

Follow the above procedure to enter other values. The order in which values are entered is dependent on the type of patient being monitored (adult or neonatal) and how the order for the drug was given.

Below you will find additional information on each element of the dose calculations information window.

- *WEIGHT* — Enter the patient's weight.
- *SOL VOLUME* (solution volume) — A default value is displayed. This value varies with the patient-monitor type and drug name chosen.
- *DRUG QTY* — If the drug quantity is entered in milligrams (*MG*), the dose/kg/min is in micrograms. The drug quantity will be calculated if the user enters a solution volume, a dose, and a rate.

  NOTE

  Be sure to select the proper drug units (*MCG/MG* or *UNITS*) for the medication when using the A, B, C, or D labels.

- *DOSE/MIN, DOSE/HR, DOSE/KG/MIN, DOSE/KG/HR* — Any one of these may be entered manually. If the volume, quantity, and rate are entered, these are calculated for you. If you change the dose, the program recalculates the other dose values.
- *INF RATE* (infusion rate) — This value represents the cc/hr that the solution infuses. If you change the infusion rate, the program recalculates the dose values.
- *DRIP RATE* — You must change this value if you are administering medication with a pump that counts drops and the pump's drop size is not 60 gtt/cc.
- *DROP SIZE* — This represents the administration setup used by the IV pump.
- *INF TIME* (infusion time) — If you enter the solution volume, drug quantity, and infusion time, the program will calculate the infusion rate and the dose.

Save Calc

This is a direct action menu option. Select *SAVE CALC* to store the set of dose calculations displayed on the screen. Here are some guidelines to remember when saving dose calcs:

- An incomplete calculation cannot be saved.
- If you save a calculation that has the same drug name as a previously saved calculations, the new calculation will replace the previous one.
- Four sets of calculations can be saved. When saving a fifth calculation, a message is displayed, asking that a calculation be deleted before storing this calculation.

Recall Saved Calc

Select this menu option to display a list of saved calculations. A popup menu opens, listing the saved calculations. Select the calculation you wish to recall.

The information window immediately displays the requested set of calculations. Select *RETURN* in the popup menu to close it and return to the Dose Calcs menu. The recalled calculation remains in the information window. If necessary, this calculation set can be changed and resaved.

The displayed calculations can be printed by pressing the **Graph Go/ Stop** button.

Delete Calc

Select this menu option to delete one or more sets of calculations. A popup menu opens, listing the saved calculations.

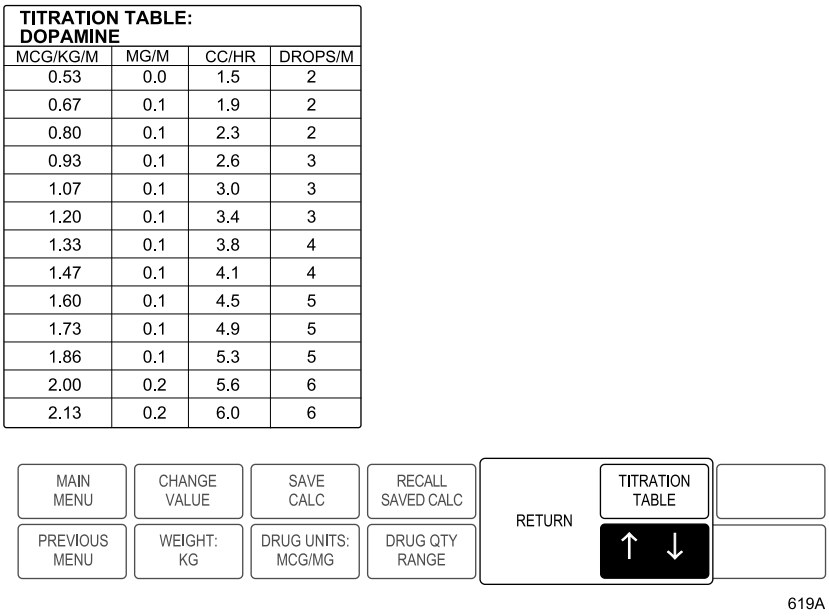
Highlight a calculation. You can highlight as many as you wish to delete. When you have highlighted all the calculations you wish to delete, select *RETURN* to delete them and close the popup menu.

NOTE

If the calculation is displayed in the information window at the time of deletion, it will remain on the display. However, if you modify the information window or exit the dose calcs program, the deleted calculation will no longer be available.

Titration Table

To view a titration table for a drug, first complete a drug dose calculation set. (It is advisable to save the set.) With the calculation displayed on the screen, select *TITRATION TABLE* from the Dose Calcs menu. A popup menu and the titration table appear.



Titration Table Popup Menu and Information Window

To close the titration table and popup menu, press the Trim Knob control or touch *RETURN*. The drug calculation set is redisplayed in the information window.

Weight

Selecting this option switches units for the patient's weight between kilograms and pounds. Changing this does not affect any calculations as drug dosage is always calculated per kilogram of weight. If the patient's weight is entered in pounds, the program converts to kilograms before calculating (not seen by the user).

Drug Units

Selecting this option switches the drug units between grams (*MCG/MG*) and *UNITS*. This option is used when labeling a drug A, B, C, or D, since the normal measurement of the drug you labeled is unknown.

Drug Quantity Range

Selecting this menu option opens a popup menu, from which you can determine the default used when entering a value for drug quantity. This option is used when labeling a drug A, B, C, or D.

- Select *0.01-100* to enter 1.0 MG or units for the drug quantity.
- Select *100-1000* to enter 10.0 MG or units for the drug quantity.
- Select *1000-10,000* to enter 100.0 MG or units for the drug quantity.
- Select *>10,000* to enter 1000.0 MG or units for the drug quantity.

Resuscitation Medications

This option appears only when the monitor is set for Neonatal-ICU mode. Selecting this menu option opens a popup menu and information window which provides information and dosages for neonatal resuscitation medications.

NOTE

The patient's weight must be entered before this option can be selected.

Select *RETURN* in the popup menu to close the popup menu and information window.

CRG Trends

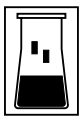
NOTE

This option is part of the High Resolution CRG Trends software package.

Selecting this option creates a high-resolution trend window for up to three CRG Plus parameters. A new menu is also displayed with this window. Refer to Chapter 9, CRG Plus Display, for more information.

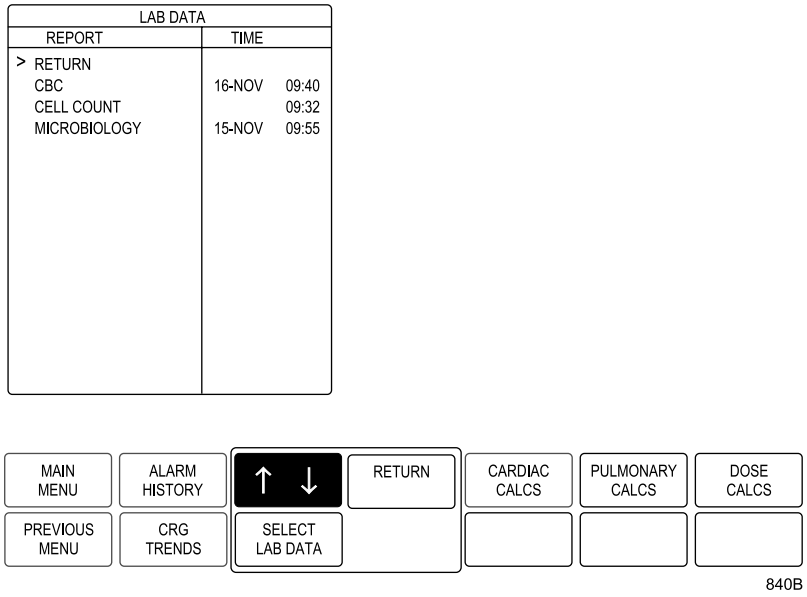
Lab Data

If your monitoring system includes a Solar Lab Access Server and an interface to the lab information system (LIS), you can access the patient's laboratory data at the monitor. While monitoring, you will be notified that new lab data for the patient is available when the lab data icon is shown at the top middle of the monitor's display. The icon looks similar to the one below.


844A

Lab Data Icon

Select the *LAB DATA* option from the Patient Data menu to display a screen similar to the one below. (If your system does not have the necessary equipment, a message is displayed below the menu when you attempt to select this option.)



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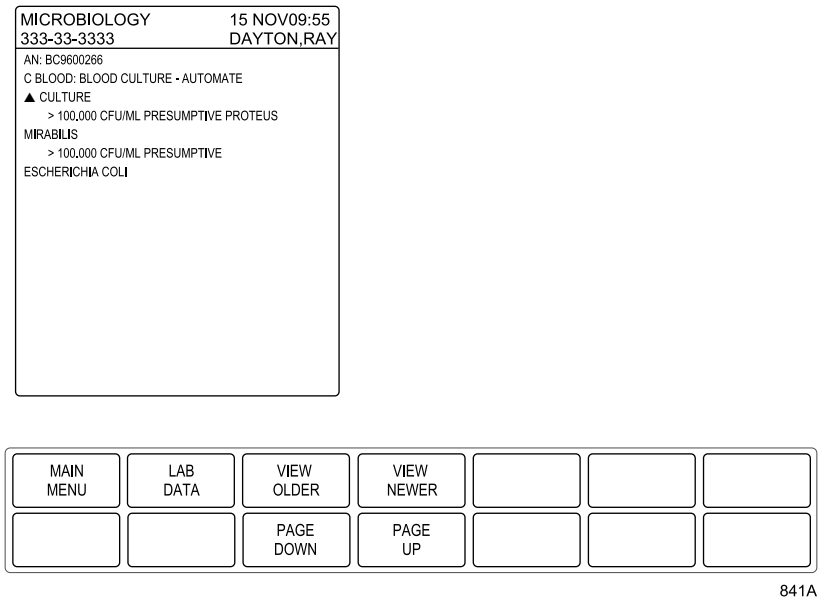
Lab Data Information Window

The information window lists, by groups, laboratory data that has been entered in the LIS database. The date and time of the most current report within each group is also displayed. Date and time stamps on reports are assigned by the lab.

Select the group you want to access. Another information window is displayed. How the information is presented varies with the type of report. See the following examples.

For all types of reports, you can use the menu options *VIEW OLDER*, *VIEW NEWER*, *PAGE DOWN*, and *PAGE UP* to view additional data, if there is any. You can also press the **Graph Go/Stop** button to print the information window to the print window location.

Example 1 is a list of reports associated with the selected group.

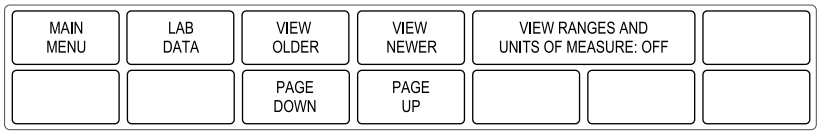


Lab Report Example 1

Example 2 is a list of associated reports presented in a tabular format. In this example, the view ranges and units feature is off.

CELL COUNT
333-33-3333 DAYTON,RAY

	16 NOV 10:00	17 NOV 10:00	17 NOV 12:10
WBC		213	213
MCHC		54	50
MCH		43	40
PLATELET		23	150
RDW		53	14
LYMPH ABS		43	
HCT			49



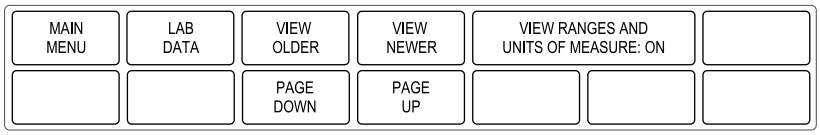
842A

Lab Report Example 2, Ranges and Units Off

Example 3 is the same lab report as shown in Example 2, only the View Ranges And Units of Measure option is turned on.

CELL COUNT
333-33-3333 DAYTON,RAY

	17 NOV 12:10	
WBC	213	01.0 – 999.9
MCHC	50	31.0 – 37.0 %
MCH	40	25.4 – 34.6 OOG
PLATELET	150	150 – 400 CMM
RDW	14	11.0 – 14.0 %
HCT	49	042.7 – 049.1 %



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Lab Report Example 3, Ranges and Units On

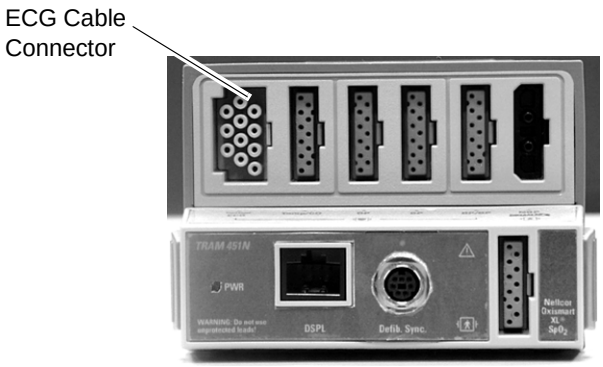
11 ECG

For your notes

Introduction

This chapter gives guidelines for proper ECG monitoring, including skin preparation, electrode placement, adjusting ECG setup, and troubleshooting.

ECG can be monitored with any of the Tram modules or Solar ECG modules.



Tram 451N Module

Solar ECG/Resp SL Module with Defib Sync

NOTE

The signal input is a high-insulation port and it is defibrillator-proof ( ).

The insulated input ensures patient safety and protects the device during defibrillation and electrosurgery.

"*NO ECG*" Comm Alarm

A programmable system alarm alerts you to intermittent or complete loss of communication with all or some of the modules. The factory default for this alarm is off, but you can set it to be a system warning or a patient crisis alarm in monitor defaults. Refer to the Setup Default Display section in Chapter 5, Monitor Setup. It is identified as "*NO ECG COMM ALARM*" in the Setup Display information window.

When the alarm is set as *SYS WARNING* or *CRISIS*, and the monitor loses communication, a tone sounds and the message "*NO ECG*" is displayed on the monitor. The alarm is also generated on the network for connected devices, such as the clinical information center.

WARNING
When communication is lost, the patient is NOT being monitored. In this state, there are no data or alarms to alert you to the patient's condition. Use alternate means of monitoring.

Checklist

1. The module is securely inserted in the Tram-rac housing.
2. Electrodes have been placed on the patient following proper skin preparation.

   NOTE

   When using “snap” leadwires, attach the leadwires to the electrodes first, then apply the electrodes to the patient. This prevents the gel from spreading and becoming ineffective as you attach the snaps to the electrodes.

3. Leadwires are attached to electrodes on the patient.
4. Leadwires are connected to patient cable and patient cable is connected to the module.
5. Verify that the V-lead label is correct if using a 5-leadwire patient cable. (Refer to the Identify V Lead section in this chapter.)
6. ECG setup is adjusted if necessary. Follow the detailed procedures in this chapter.

Skin Preparation

The quality of ECG information displayed on the monitor is a direct result of the quality of the electrical signal received at the electrode.

Proper skin preparation is necessary for good signal quality at the electrode. A good signal at the electrode provides the module with valid information for processing the ECG data.

Choose flat, non-muscular areas to place electrodes, then follow the established prep protocol for your unit. Below is a suggested guideline for skin preparation:

1. Shave hair from skin at chosen sites.
2. Gently rub skin surface at sites to remove dead skin cells.
3. Thoroughly cleanse the site with alcohol or a mild soap and water solution. Be sure to remove all oily residue, dead skin cells, and abrasives. Leftover abrasion particles can be a source of noise.
4. Dry the skin completely before applying the electrodes.

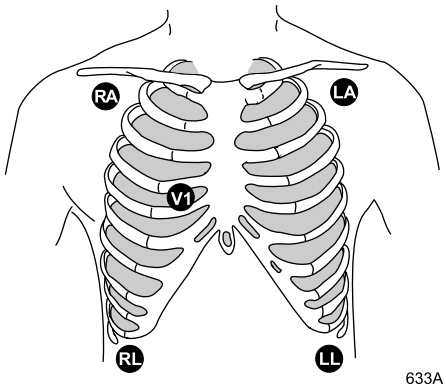
Electrode Placement

The chart below shows the label used to identify each leadwire. Included also is its associated color code per AHA and IEC standards.

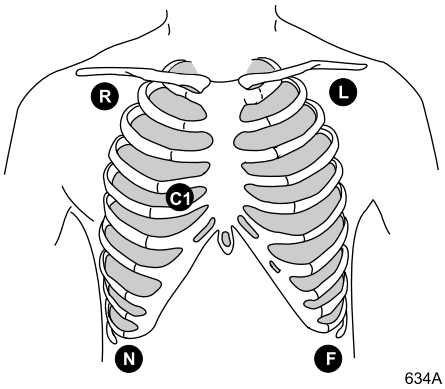
Leadwire (Software Label)	AHA Color	AHA Label	IEC Color	IEC Label
RA (right arm)	white	RA	red	R
LA (left arm)	black	LA	yellow	L
RL (right leg)	green	RL	black	N
LL (left leg)	red	LL	green	F
V1 (precordial)	brown	V1	white	C1
V2 (precordial)	yellow	V2	yellow	C2
V3 (precordial)	green	V3	green	C3
V4 (precordial)	blue	V4	brown	C4
V5 (precordial)	orange	V5	black	C5
V6 (precordial)	purple	V6	purple	C6

5-Leadwire Electrode Placement

Following is a suggested configuration when using five leadwires:



AHA configuration



IEC configuration

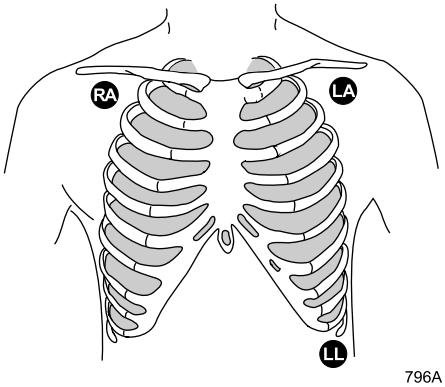
Right arm and left arm electrodes should be placed just below the right and left clavicle.

Right leg and left leg electrodes should be placed on a non-muscular surface on the lower edge of the rib cage.

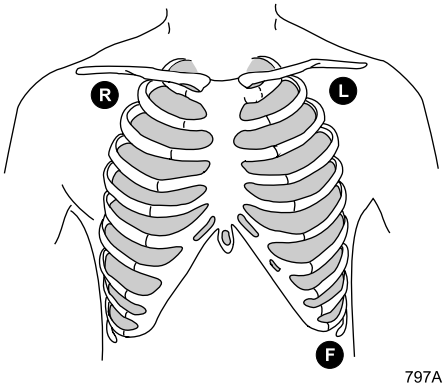
The chest electrode should be placed according to the physician's preference.

3-Leadwire Electrode Placement

When a 5-leadwire electrode configuration is not desirable, a 3-leadwire electrode configuration can be used.



AHA configuration



IEC configuration

NOTE

Electrode configuration will vary depending on the type of leadwire set you are using. Refer to the 3-Leadwire Configuration section below.

Right arm and left arm electrodes should be placed just below the right and left clavicle.

Left leg electrode should be placed on a non-muscular surface on the lower edge of the rib cage.

3-Leadwire Configuration

The molded 3-leadwire sets can be placed in the 5-lead Multi-Link patient cable.

Standard Molded 3-Leadwire Set (Rotating Reference)

- Selectable lead I, II, or III cable with a rotating reference (right arm, left arm, left leg)

Operation of the monitor with this standard cable allows you to select one of three leads (I, II, or III) for monitoring.

When using the standard, 3-leadwire configuration, the following operating conditions occur:

- *LD ANALYSIS* automatically switches to single lead analysis. If an attempt is made to change to multi-lead analysis, the message "*MULTI LEAD ANALYSIS NOT POSSIBLE WITH 3 LEAD CABLE*" will appear briefly and no change will occur.
- *DISPLAY LEAD* choices are limited to I, II, and III.
- Any options usually allowing more than one ECG lead selection are disallowed. A message line is displayed briefly, indicating such.
- Respiration can be monitored from either lead I or II. It is NOT dependent on the displayed lead.

This 3-leadwire cable is not compatible with transport LCD software version 8 or earlier, or with certain Tram modules. If this cable is connected to an incompatible Tram module, the message "*NEED CABLE WITH RL CONNECTOR*" will flash in the ECG parameter window, and a system warning alarm will sound.

NOTE

There is also an older style of 3-leadwire patient cables with a fixed right leg reference:

Lead I cable with a fixed right leg reference (right arm, left arm, left leg). Respiration is monitored from lead I only.

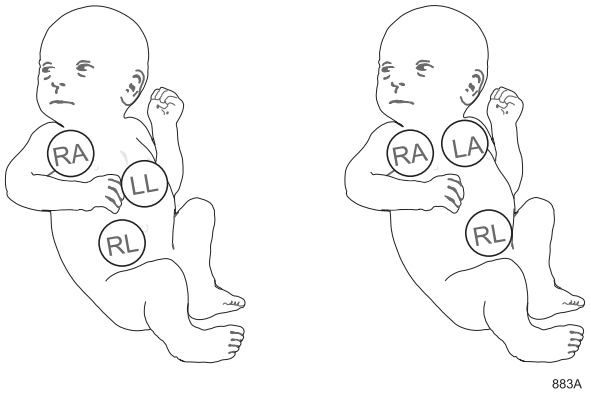
Lead II cable with a fixed left arm reference (right arm, left leg, left arm). Respiration is monitored from lead II only.

Operation of the monitor with a fixed right leg reference is limited to the fixed lead designated. If using a lead I cable, respiration is monitored from lead I, etc. If in Adult-ICU or Operating Room mode, multi-lead analysis defaults on. With a 3-leadwire cable with a fixed reference, you should change lead analysis to single lead analysis.

Electrode Placement for Neonates

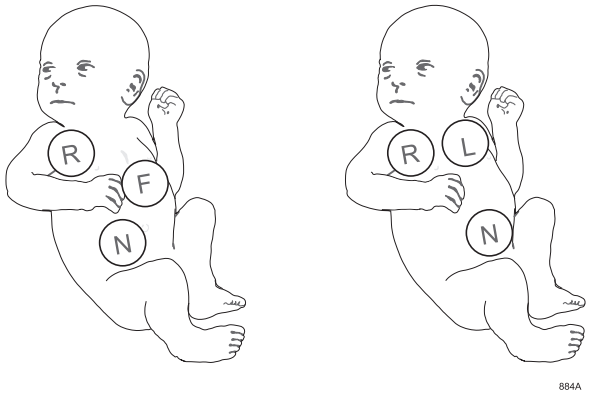
WARNING
Route cables away from patient's throat to avoid possible strangulation.

Because of the size of neonatal patients, there is usually only enough room for a 3-leadwire electrode configuration. A 3-lead neonatal ECG cable is available, and a Multi-Link DIN adapter is available for the 5-lead Multi-Link cable. The right arm and left arm or right arm and left leg electrodes are positioned on the right and left sides of the chest. The third electrode (right leg) can be placed on either the right or left side of the abdomen.



Lead II **Lead I**

AHA configuration



Lead II **Lead I**

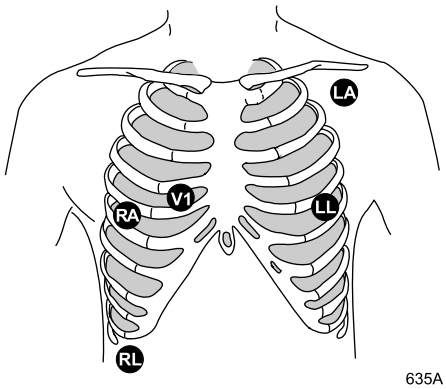
IEC configuration

Electrode Placement for Pacemaker Patients

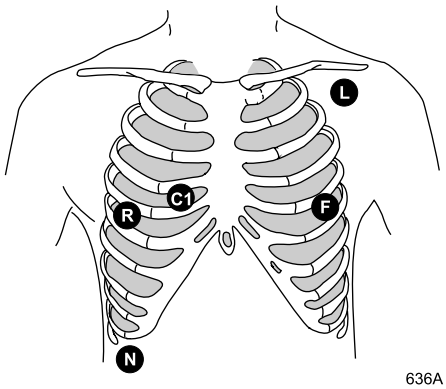
Electrodes need to be repositioned to modify detection of the electrical signals generated by the pacemaker. Following is a suggested configuration.

NOTE

When using this configuration, display lead II as your primary ECG lead.



AHA configuration



IEC configuration

The right arm electrode is moved down to the fifth intercostal space, and the left leg electrode is moved up to the fifth intercostal space.

NOTE

After all electrodes are in place, ensure that a minimum of 1/2 mV of signal is present on each lead (I, II, III, V).

10-Leadwire Electrode Configuration for 12SL Monitoring

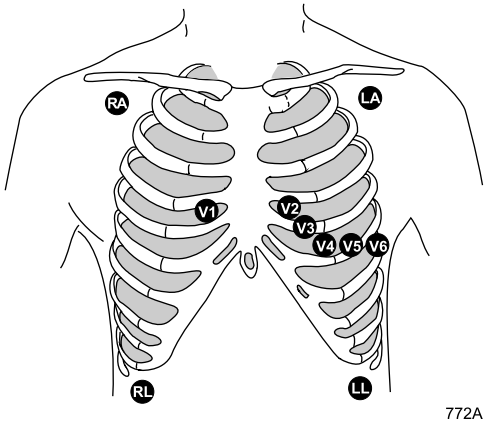
WARNING

To assure accurate 12-lead analysis when using a 10-leadwire patient cable, you must verify that the correct leadwire block is plugged into the appropriate side of the cable. The V2 through V6 leadwire block is color coded brown.

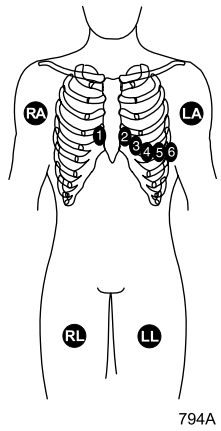
A suggested electrode configuration for traditional monitoring, and an alternate, traditional cardiology configuration are shown below.

NOTE

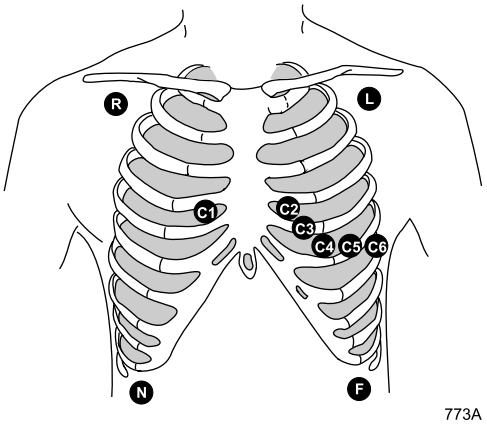
For the most accurate serial comparisons, use the same electrode configuration as used on prior analyses for the patient.



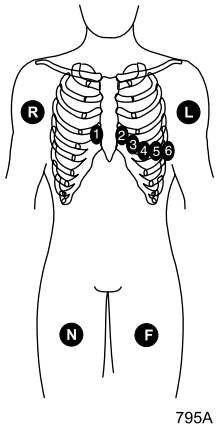
Traditional Monitoring AHA Electrode Configuration



Traditional Cardiology AHA Electrode Configuration



Traditional Monitoring IEC Electrode Configuration



Traditional Cardiology IEC Electrode Configuration

For traditional monitoring, right arm and left arm electrodes should be placed just below the right and left clavicles. For traditional cardiology (resting ECG), place them on the arms, off the torso.

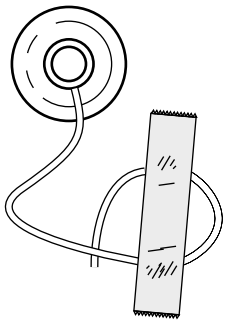
For traditional monitoring, right leg and left leg electrodes should be placed on a flat non-muscular surface below the rib cage. For traditional cardiology (resting ECG), place them on the upper leg.

The six chest electrodes should be placed as indicated below:

1. Fourth intercostal space at the right border of the sternum.
2. Fourth intercostal space at the left border of the sternum.
3. Midway between locations 2 and 4.
4. At the mid-clavicular line in the fifth intercostal space.
5. At the anterior axillary line on the same horizontal level as 4.
6. At the mid-axillary line on the same horizontal level as 4 and 5.

Maintaining Quality ECG Signal

Regardless of patient age, electrodes should be replaced AT LEAST every 48 hours to maintain quality signals during long-term monitoring. Over the course of 48 hours, the electrode gel will start to dry out and the adhesive will age. After a long period of time, the patient's sensitive skin also may be irritated by the gel or adhesive, causing discomfort.


637A

Stabilize the electrode and leadwire with a leadwire stress loop near the electrode. Tape the stress loop to the patient. A secured stress loop prevents leadwire rotation about the electrode snap, leadwire tugging at the electrode, and ECG artifact.

Surgical Considerations for Electrode Placement (Adults)

Thorough skin preparation is very important to help keep ESU interference to a minimum. Do a thorough skin prep to the skin next to the grounding pad as well.

Place the right leg electrode close to the ESU grounding pad.

ESU ECG Filters

Electrosurgical Unit (ESU) Cable

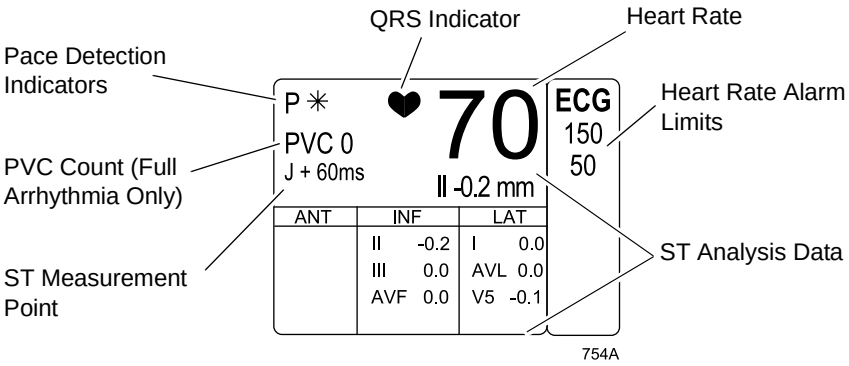
The Multi-Link ESU ECG patient cable is recommended when using the monitor in the presence of an electrosurgical unit. This cable, with a built-in ESU filter, helps reduce electrosurgical noise detected on the ECG signal.

ECG Monitoring Features

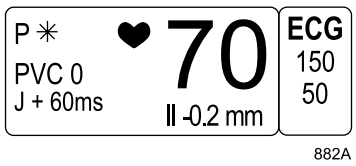
ECG Display

An ECG waveform is always displayed at the top of the monitor's screen. Depending on the default settings, more may be displayed.

An ECG parameter window is also displayed. The size of the ECG parameter window varies, depending on the default parameter priority setting in monitor defaults. Your software package and parameter settings determine the information displayed in the window.



ECG Parameter Window (Large)



ECG Parameter Window (Small)

The parameter window displays the current heart rate, pacemaker indicators, PVC count (full arrhythmia only), and the ECG lead with the greatest ST deviation (when ST analysis is on).

NOTE

The anterior (*ANT*), inferior (*INF*), and lateral (*LAT*) ST data, as shown above, is only displayed when ST is selected as the parameter 2 default in monitor defaults.

The monitor displays alarm limits, but you can choose to turn them off in monitor defaults.

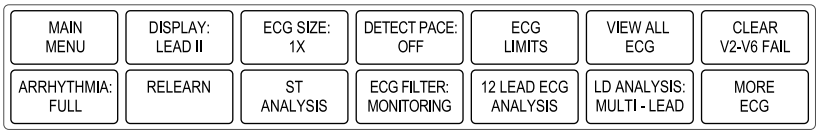
A QRS indicator (flashing heart) and a flashing asterisk for each detected pacemaker spike (when pacemaker detection is on) are also displayed.

Use the ECG parameter menu to make changes during monitoring.

ECG Menu

Getting to the ECG Menu

To display the ECG menu, select the ECG label. The ECG menu is then displayed at the bottom of the screen.



ECG Menu

- *DISPLAY LEAD* — Changes the top displayed (primary) ECG lead.
- *ECG SIZE* — Changes the size of all ECG waveforms displayed and graphed.
- *DETECT PACE* — Turns pacemaker detection on and off, accesses pace help.
- *ECG LIMITS* — Displays a new menu and an information window to adjust heart rate alarm limits.
- *VIEW ALL ECG* — Displays six leads of ECG.
- *CLEAR V2-V6 FAIL* — Clears the "*V2-V6 FAIL*" message displayed on the screen when only using the 5-leadwire part of a 10-leadwire cable.
- *ARRHYTHMIA* — Turns arrhythmia processing on and off. Full and Lethal choices are available in the Cardiac software package.
- *RELEARN* — Relearns the patient's QRS pattern.
- *ST ANALYSIS* — Turns on the ST analysis program.
- *ECG FILTER* — Selects one of four filters for the ECG signal.
- *12 LEAD ECG ANALYSIS* — Displays 12 leads of ECG with special menu options for analyzing and printing.
- *LD ANALYSIS* — Selects single-lead or multi-lead ECG and arrhythmia processing.
- *MORE ECG* — Displays a new menu with options to turn the QRS tone on and off, adjust the volume when on, specify the QRS width type, and adjust the speed.

Detailed information on each option is found in this chapter.

Display Lead

This option allows you to change the lead displayed as the primary lead—the one in the top trace position. This is useful when you are selecting a lead for pacemaker detection or analog output.

Select the *DISPLAY LEAD* option from the ECG menu. A popup menu opens, showing all leads available. The lead currently being displayed is highlighted.

NOTE

There is only one V lead choice, even if you are using a 10-leadwire cable. The V lead available is determined by the V lead identified in the ST menu.

If you are using a standard (selectable lead), three-leadwire cable, the available choices in the popup menu are leads I, II, and III.

Highlight the desired lead. The change occurs immediately on the screen. When you are satisfied with the lead selection, press the Trim Knob control or touch the *DISPLAY LEAD* option to close the popup menu.

Synchronized Cardioversion

The lead displayed in the top trace position is the signal output to the **DEFIB SYNC** connector on the front of the module. The software provides a defib sync pulse for digital synchronization and places a return marker on the ECG waveform.

If the defibrillator is to be synchronized with the analog ECG signal, review the patient's ECG leads and place the one with the greatest amplitude in the top position on the monitor.

Smart-Lead Fail

NOTE

The smart-lead fail feature works only when using a 5-leadwire or 10-leadwire configuration.

The smart-lead fail feature continually checks the integrity of the electrodes to allow uninterrupted monitoring. If the quality of an electrode signal degrades to an inadequate level, a lead fail message is displayed. If the lead fail affects the ECG waveform being monitored in the top trace position on the screen, monitoring automatically switches to another lead. Refer to the chart below.

Message	New Lead Monitored
RA FAIL	Lead III
LL FAIL	Lead I
LA FAIL	Lead II
V FAIL	Lead II
LEADS FAIL	No waveforms displayed — right leg fail or leads fail

If you are using a 10-leadwire electrode configuration, you have the additional V2-V6 leads. If one of these V leads fails while it is displayed in the top trace position, monitoring will switch to lead II.

Individual lead fail messages are not displayed when using single-lead analysis, but lead switching does occur.

Leads Fail Patient Condition

There is a system alarm to alert you when more than one lead fails. In the Operating Room mode, this leads fail patient condition defaults as a system advisory alarm. You can, however, set it to a crisis alarm in monitor defaults.

In Adult-ICU and Neonatal-ICU modes, this alarm defaults to a system warning alarm, but can be set to a crisis alarm in monitor defaults. Refer to the Setup Default Display section in Chapter 5, Monitor Setup.

ECG Size

This option enables you to change the size of all ECG waveforms displayed on the screen. This may be necessary when diagnosing or problem-solving. Normal size (1X) is recommended unless circumstances require otherwise.

NOTE

If a size other than 1X is used, the size is displayed on the left side of the screen next to the ECG waveform.

Size 2X and greater will lower the QRS detection threshold. This may be helpful for low amplitude QRS waveforms. Use with caution since baseline artifact may be detected as a QRS complex.

Waveforms are graphed at the same size as they are displayed.

ST complexes are displayed based on the ECG size selected, but always print at 1X size.

Selecting the *ECG SIZE* option from the ECG menu opens a popup menu. Size options are *4X*, *2X*, *1X*, and *0.5X*. The current size for all displayed ECG waveforms is highlighted.

Rotate the Trim Knob control or use the touchscreen arrows to change the size. The change occurs immediately on the screen. When you are satisfied with the selection, press the Trim Knob control or touch the *ECG SIZE* option to close the popup menu.

Detect Pace

Safety Considerations

Be aware of the following when monitoring a patient with a pacemaker.

WARNINGS

FALSE CALLS—False low heart rate indicators or false asystole calls may result with certain pacemakers because of electrical overshoots.

MONITORING PACEMAKER PATIENTS—Monitoring of pacemaker patients can only occur with the pace program activated.

PACEMAKER SPIKE—An artificial pacemaker spike is displayed in place of the actual pacemaker spike. All pacemaker spikes appear uniform. Do not diagnostically interpret pacemaker spike size and shape.

PATIENT HAZARD—A pacemaker pulse can be counted as a QRS during asystole in either pace mode. Keep pacemaker patients under close observation.

RATE METERS—Keep pacemaker patients under close observation. Rate meters may continue to count the pacemaker rate during cardiac arrest and some arrhythmias. Therefore, do not rely entirely on rate meter alarms.

CAUTION

FDA POSTMARKET SAFETY ALERT—The United States FDA Center for Devices and Radiological Health issued a safety bulletin October 14, 1998. This bulletin states “that minute ventilation rate-adaptive implantable pacemakers can occasionally interact with certain cardiac monitoring and diagnostic equipment, causing the pacemakers to pace at their maximum programmed rate.”

The FDA further recommends precautions to take into consideration for patients with these types of pacemakers. These precautions include disabling the rate responsive mode and enabling an alternate pace mode. For more information contact:

Office of Surveillance and Biometrics, CDRH, FDA
1350 Piccard Drive, Mail Stop HFZ-510
Rockville, MD 20850
U.S.A.

NOTE

ECG monitoring with patients on non-invasive transcutaneous pacemakers may not be possible due to large amounts of energy produced by these devices. Monitoring ECG with an external device may be needed.

Monitoring Pacemaker Patients

The *DETECT PACE* menu option enables/disables the pacemaker detection program. It must be used whenever the monitored patient has a pacemaker. Pace detection choices are *PACE 1*, *PACE 2*, and *OFF*.

NOTE

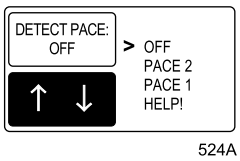
The *OFF* option turns pacemaker detection off. It does NOT perform pacemaker detection. It should NOT be used for patients with pacemakers.

NOTE

Moderate and maximum ECG filtering is not recommended with pacemaker patients. (Refer to the ECG Filter section in this chapter.)

There are two pacemaker processing modes, Pace 1 and Pace 2. The Pace 1 and Pace 2 modes use different algorithms for pacemaker artifact rejection. The clinician must be the judge as to which mode is better for each patient. The pacemaker detection program defaults off so if you have a patient with a pacemaker, you will have to turn the program on. Follow this procedure:

1. Select the *DETECT PACE* option from the ECG menu. A popup menu opens.



Detect Pace Popup Menu

2. Rotate the Trim Knob control or use the touchscreen arrows to move the pointer is in front of your choice.

   The *PACE 2* mode is much more conservative in recognizing paced QRS morphologies and is recommended for use whenever possible. It is designed to minimize the possibility of counting pacemaker artifact as QRS complexes during *ASYSTOLE*. If the monitor does not adequately detect paced beats in the *PACE 2* mode, then the user may wish to try the *PACE 1* mode.

   NOTE

   Please observe all cautions as described when choosing the PACE 1 mode of operation.

The *PACE 1* mode allows successful detection of the largest variety of paced QRS morphologies. As a direct consequence, this mode does have a higher risk of counting pacemaker artifact as QRS complexes during *ASYSTOLE*. For this reason, it is imperative that the user keep patients with pacemakers under close observation. It is also recommended that the user set the low heart rate limit on the monitor close to the minimum pacing rate, and that the *BRADY* arrhythmia alarm level be elevated to a *WARNING* or *CRISIS* level.

3. Press the Trim Knob control or touch the *DETECT PACE* option to confirm the change and close the popup menu.

When either pace mode is enabled, the software places an artificial spike on the waveform whenever the pacemaker triggers. When pacemaker detection is on, it is indicated by a "*P*" in the patient's ECG parameter window.

For successful monitoring of pacemaker patients, follow these suggestions:

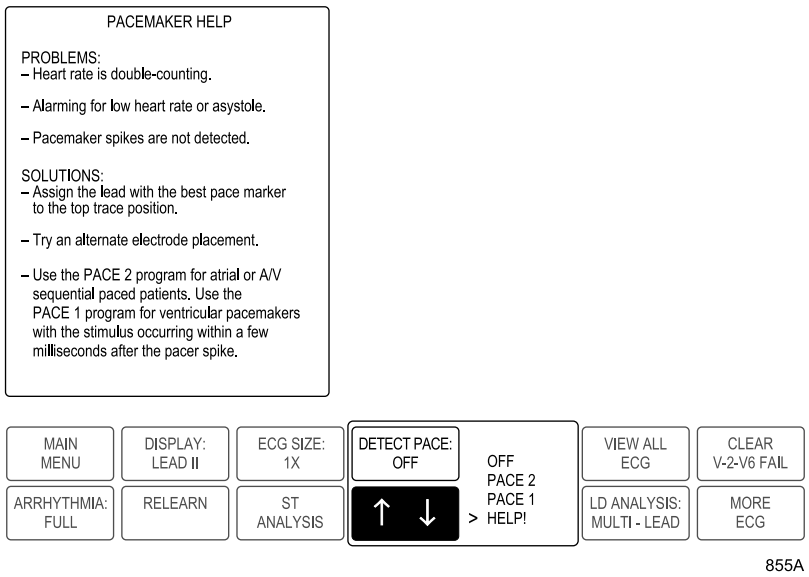
- Use recommended electrode placement. (Refer to the Electrode Placement section in this chapter.)
- Brady, Pause, and Low Heart Rate are additional alarms available for use when monitoring pacemaker patients.
- Problems you may experience are:
  - heart rate double counting;
  - inaccurate alarms for low heart rate or asystole;
  - pacemaker spikes not recognized by the software.
- Possible solutions to above problems are:
  - relearn arrhythmia;
  - try an alternate electrode placement;
  - try single-lead analysis;
  - try switching to the other pace detection mode.
- Pacemaker mode:
  In most cases, *PACE 2* mode will effectively monitor a pacemaker patient. However, if you are experiencing problems, select the *PACE 1* mode as an option, and observe all cautions as described for the Pace 1 mode of operation.

Here are some additional guidelines for successful monitoring pacemaker patients from a Solar or Tram module:

- SOLAR ECG/RESP SL module — When using the 10-leadwire patient cable with all electrodes attached, pace detection occurs on any V lead selected for the top trace position.
- TRAM SL modules — Tram SL modules must have specific hardware to do pace detection on leads V2-V6 when using the 10-leadwire patient cable with all electrodes attached. If the Tram module does not have this hardware, then pace detection uses the V1 lead no matter which V lead is selected for the top trace position.
  - How do you know if your Tram module has the necessary hardware? Select *MORE MENUS* > *MONITOR SETUP* > *SOFTWARE REVISION*. Look at the Tram module software version. If there is a number 3 preceding the date, then the module has the necessary hardware.
- For more information refer to Pacemaker Troubleshooting in this chapter.

Pace Help

Selecting the *HELP!* option opens a window that shows common problems and solutions in regard to pacemaker detection. This window is shown below.


PACEMAKER HELP
PROBLEMS:
– Heart rate is double-counting.
– Alarming for low heart rate or asystole.
– Pacemaker spikes are not detected.
SOLUTIONS:
– Assign the lead with the best pace marker to the top trace position.
– Try an alternate electrode placement.
– Use the PACE 2 program for atrial or A/V sequential paced patients. Use the PACE 1 program for ventricular pacemakers with the stimulus occurring within a few milliseconds after the pacer spike.
MAIN MENU
DISPLAY: LEAD II
ECG SIZE: 1X
DETECT PACE: OFF
OFF
PACE 2
PACE 1
> HELP!
VIEW ALL ECG
CLEAR V-2-V6 FAIL
ARRHYTHMIA: FULL
RELEARN
ST ANALYSIS
LD ANALYSIS: MULTI - LEAD
MORE ECG
855A

Pace Help Popup Menu and Information Window

Selecting any of the options in the popup menu closes the popup menu and the information window.

ECG Limits

Select *ECG LIMITS* to open an information window and a new menu, which allows you to adjust the following:

- Heart rate (HR) high and low limits
- PVC per minute limit
- Turn the PVC per minute limit on and off

NOTE

PVC Limit is a feature in the Cardiac software package only.

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

PVCs Per Minute

NOTE
This option is part of the Cardiac software package.

An alarm occurs if the PVC count limit is violated. This is a PVC per minute limit.

This alarm feature defaults on with full arrhythmia. If full arrhythmia is on, the PVC limit alarm can be independently turned off using the *PVC LIMIT ON* menu option. This is a direct action menu option that switches between on and off.

The number of PVCs detected over the last minute is displayed in the ECG values window when full arrhythmia is on.

Artifact Alarm

ECG artifact generates an alarm. All artifact alarms begin at level 1 and progress to level 2 when noise on the ECG lasts for 20 of the last 30 seconds.

- Level 1 — Upon detection of artifact, the message "*ARTIFACT*" is displayed. There is no alarm tone.

  NOTE
  Full arrhythmia processing is suspended when the level 1 "*ARTIFACT*" message is displayed. Lethal arrhythmia is still active, but its accuracy may be hindered by the artifact.

- Level 2 — Heart rate and PVC values change to *X*, an additional message, "*ARRHY SUSPEND*," is displayed, and a system warning alarm (repeating foghorn tone) sounds.

View All ECG

To view six leads of ECG on the display, select the *VIEW ALL ECG* option from the ECG menu. A popup menu opens and the display is reconfigured to show six ECG leads — I, II, III, V, AVL, and AVF. (This assumes that you are using five electrodes on your patient.)

Press the Trim Knob control or touch the *VIEW ALL ECG* option to close the popup menu and return to the normal display.

Print All ECG

To print all ECG waveforms, press the **Graph Go/Stop** button on the keypad when the view all ECG option is selected. The information is printed to the writer selected as the print window location. (Refer to the Graph Setup section in Chapter 5, Monitor Setup.)

Clear V2-V6 Fail

There may be instances when you use the 10-leadwire cable for routine monitoring. In these instances, you may only use the standard 5-leadwire portion of the cable. The monitor displays the message "*V2-V6 FAIL*" when it does not detected the extra V leads. Use the *CLEAR V2-V6 FAIL* menu option to clear this message from the screen.

Arrhythmia

WARNINGS

VENTRICULAR ARRHYTHMIAS — The arrhythmia analysis program is intended to detect ventricular arrhythmias. It is not designed to detect atrial or supra-ventricular arrhythmias. Occasionally it may incorrectly identify the presence or absence of an arrhythmia. Therefore a physician must analyze the arrhythmia information in conjunction with other clinical findings.

SUSPENDED ANALYSIS — Certain conditions suspend arrhythmia analysis. When suspended, arrhythmia conditions are not detected and alarms associated with arrhythmias do not occur. The messages which alert you to the conditions causing suspended arrhythmia analysis are: *ARR OFF, ARHY SUSPEND, LEADS FAIL, ALARM PAUSE*, ALL ALARMS OFF**, and *DISCHARGED**.

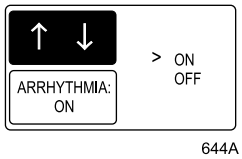
*** NOTE**

Arrhythmia messages are displayed when *ALARM PAUSE, ALL ALARMS OFF,* or *DISCHARGED* is displayed, but there are no alarm tones or history storage.

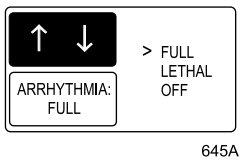
The EK-Pro algorithm simultaneously uses leads I, II, III, and the V lead for ECG and arrhythmia analysis. The Basic software package detects lethal arrhythmias only. The Cardiac software package has full arrhythmia analysis.

Turning Arrhythmia On and Off

To manually turn arrhythmia analysis off and on, select the *ARRHYTHMIA* option from the ECG menu. A popup menu opens. The choices available are determined by the software package.



Arrhythmia Popup Menu — Basic Software Package



Arrhythmia Popup Menu — Cardiac Software Package

Select your arrhythmia analysis choice. The change does not take effect until the popup menu is closed.

NOTE

The message "*ARR OFF*" appears in the ECG parameter window when arrhythmia is turned off. This message is not displayed when the monitor is in Operating Room mode.

Turning arrhythmia on automatically starts a relearn procedure.

Lethal Arrhythmia

Lethal arrhythmias are Asystole, VFib/VTac, and V Tach, except in the Neonatal-ICU mode. In the Neonatal-ICU mode, Asystole, VFib/VTac, and Brady are the lethal arrhythmias. Refer to the Arrhythmia Conditions section in this chapter for arrhythmia definitions.

Use the *ARRHYTHMIA* option in the ECG menu to turn lethal arrhythmia on and off. (Refer to the Turning Arrhythmia On and Off section in this chapter.)

Full Arrhythmia

NOTE

This option is part of the Cardiac software package.

Full arrhythmia expands the number of arrhythmias that the program detects. (Refer to the complete list in this chapter.)

Use the *ARRHYTHMIA* option in the ECG menu to turn full arrhythmia on and off. (Refer to the Turning Arrhythmia On and Off section in this chapter.)

Full arrhythmia analysis includes a PVC per minute limit alarm. The number of PVCs detected over the last minute is displayed in the ECG values window.

Arrhythmia Conditions

Below is an alphabetical list of the arrhythmia messages which are displayed when arrhythmia is on and the condition occurs. Definitions of each condition are included. The monitor's response to each condition is determined by the alarm level to which the arrhythmia has been assigned. Refer to the Arrhythmia Alarm Level section in Chapter 8, Alarm Control for more information.

ACC VENT

Adult—Accelerated ventricular occurs when six or more ventricular beats are detected with an average heart rate for the ventricular beat between 50 and 100 beats per minute.

0-2 years—Occurs when six or more ventricular beats are detected with an average heart rate for the ventricular beat between 60 and 160 beats per minute.

3-10 years—Occurs when six or more ventricular beats are detected with an average heart rate for the ventricular beat between 60 and 140 beats per minute.

11-13 years—Occurs when six or more ventricular beats are detected with an average heart rate for the ventricular beat between 60 and 130 beats per minute.

ASYSTOLE

Ventricular asystole occurs whenever the displayed heart rate drops to zero.

BIGEMINY

Occurs when three or more bigeminal cycles (a ventricular beat followed by a non-ventricular beat) are detected.

BRADY

Bradycardia is the average of the most recent eight R-to-R intervals at a heart rate less than the set LOW heart rate limit.

NOTE

The Brady limit matches the low heart rate limit. If the low heart rate limit is changed, the Brady limit changes.

COUPLET

Occurs when two ventricular beats are detected and have non-ventricular beats before and after the couplet. The coupling interval must be less than 600 milliseconds.

IRREGULAR

Occurs when six consecutive normal R-to-R intervals vary by 100 milliseconds or more.

PAUSE	Occurs when a 3-second interval without a QRS complex is detected.
PVC	Isolated premature ventricular complexes occur when a premature ventricular beat is detected and has non-ventricular beats before and after.
R ON T	Occurs when a ventricular complex is detected within the repolarization period of a non-ventricular beat.
TACHY	Tachycardia is four R-to-R intervals at a heart rate greater than the set HIGH heart rate limit.

NOTE

The Tachy limit matches the high heart rate limit. If the high heart rate limit is changed, the Tachy limit changes.

TRIGEMINY	Occurs when three or more trigeminal cycles (a ventricular beat followed by two non-ventricular beats) are detected.
V BRADY	**Adult**—Ventricular bradycardia occurs when a run of three or more ventricular beats is detected with an average heart rate that is less than or equal to 50 beats per minute. **0-2, 3-10, and 11-13 years**—Occurs when a run of three or more ventricular beats is detected with an average heart rate that is less than or equal to 60 beats per minute.
VFIB/ VTAC	Ventricular fibrillation occurs when the ECG waveform indicates a chaotic ventricular rhythm.

WARNING

VFIB/VTAC should not be considered a substitute for the *V TACH* arrhythmia call. Efforts to lower the *V TACH* alarm level can result in missed ventricular tachycardia alarms.

V TACH

Adult—Ventricular tachycardia occurs when a run of six or more ventricular beats is detected with an average heart rate greater than or equal to 100 beats per minute.

0-2 years—Occurs when a run of six or more ventricular beats is detected with an average heart rate greater than or equal to 160 beats per minute.

3-10 years—Occurs when a run of six or more ventricular beats is detected with an average heart rate greater than or equal to 140 beats per minute.

11-13 years—Occurs when a run of six or more ventricular beats is detected with an average heart rate greater than or equal to 130 beats per minute.

VT > 2

Adult—Ventricular tachycardia >2 occurs when a run of ventricular beats is detected with a duration of less than six beats but longer than two beats and with an average heart rate that is greater than or equal to 100 beats per minute.

0-2 years—Occurs when a run of ventricular beats is detected with a duration of less than six beats but longer than two beats and with an average heart rate that is greater than or equal to 160 beats per minute.

3-10 years—Occurs when a run of ventricular beats is detected with a duration of less than six beats but longer than two beats and with an average heart rate that is greater than or equal to 140 beats per minute.

11-13 years—Occurs when a run of ventricular beats is detected with a duration of less than six beats but longer than two beats and with an average heart rate that is greater than or equal to 130 beats per minute.

Relearn

During ECG monitoring, you may need to use the *RELEARN* option when a dramatic change in the patient's ECG pattern has occurred. A change in the ECG pattern could result in:

- Incorrect arrhythmia calls,
- Loss of ST measurements, and/or
- Inaccurate heart rate.

The Relearn option allows the monitor to learn the new ECG pattern to correct arrhythmia calls and heart rate value, and to restore ST measurements.

Select the *RELEARN* option from the ECG menu. This is a direct action menu option.

During the learning process, an *X* replaces the heart rate value in the ECG values window, and the message *"LEARNING"* appears on the display.

NOTE

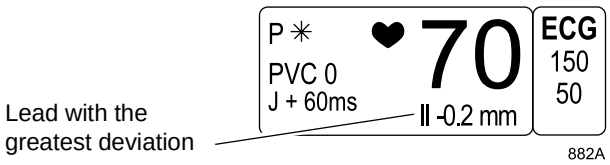
Whenever arrhythmia is turned on, a relearn automatically takes place.

ST Analysis

Numerics

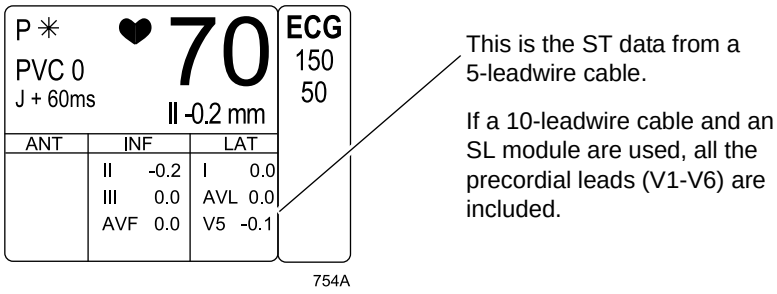
The ST analysis program is performed on multiple leads simultaneously. It identifies the ST segment of the QRS complex as beginning at the J point and ending PREDETERMINED milliseconds following the J point. (Refer to the Adjust ST section in this chapter.) The displayed ST numerics indicate either a positive or negative deviation in relation to the isoelectric reference point (I), which is also determined by the program.

When ST analysis is on, the lead with the greatest deviation is displayed in the ECG parameter window.



ECG Parameter Window with ST Analysis On

Or, if your monitor defaults have the second priority parameter set to ST, the ST values for all leads are displayed. The leads are classified in groups — anterior, lateral, and inferior.



Large ECG Parameter Window with ST Analysis On

The leads associated with each group are:

- Anterior (ANT) — V1, V2, V3, V4
- Inferior (INF) — II, III, AVF
- Lateral (LAT) — I, AVL, V5, V6

There is also an individual ST value displayed under each ECG lead label for each ECG waveform displayed on the screen.

ST numerics change to X if the monitor does not observe a rhythm that sufficiently matches the learned rhythm during the most recent 30 seconds of monitoring. If this rhythm is not an arrhythmia, the monitor will resume display of ST values in about 30 seconds.

Numerics are updated approximately every two seconds. Negative deviations are always preceded by a minus sign (-).

Trends and Complexes

NOTE

This option is part of the Cardiac software package.

Additionally, there is an ST display comprised of three, 30-minute ST trends and three ECG complexes. (See the figure below.) The leads for this display are selectable and can be set in monitor defaults. This display is treated as a waveform and can be turned off or repositioned through the waveforms on/off option in the monitor setup menu.

NOTE

Trends and complexes are not available from a telemetry transmitter when using combination monitoring (Combo, Rover Combo).

ST Trend Display

These are 30-minute, real-time trends. Each trend is marked with the appropriate lead label. The leftmost trend shows scaling information—the default is ± 2mm. There are three other scale choices available in the trend scale menu option in the ST menu.

NOTE

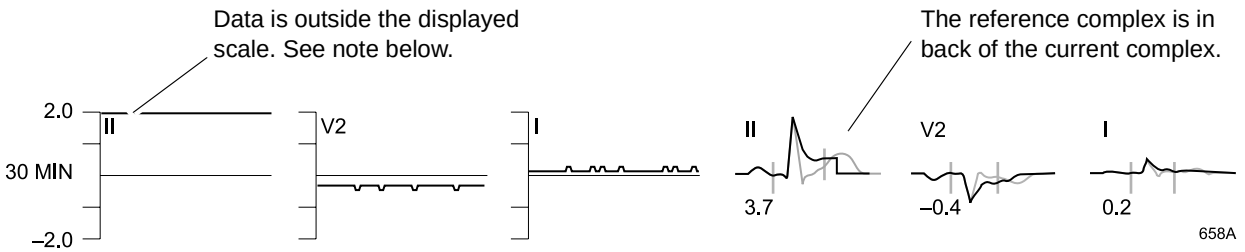
In Operating Room mode, the third trend is always a summation (*SUM*) trend of the absolute values of all monitored leads, not just those in the ST trend display.

ST Complex Display

A reference complex for each of the selected leads is displayed for visual reference purposes when ST is on. After a short time, the program displays a current ST complex for each lead. The current complex is superimposed over the reference complex. These current complexes are updated every 16 beats and can visually be compared to the reference complex to see ST segment changes.

The I point and ST reference point are determined by the program and marked with a vertical tick (gray color). The appropriate lead label is displayed next to each complex.

Use the store new references option to make the current complexes the reference complexes. This does not affect ST analysis or arrhythmia analysis.



ST Trends and Complexes Display

NOTE

When data falls outside the upper or lower scale boundaries, the trend appears as a straight line at the end of the scale. Adjust the scale so the data is within the scale to see the true trend.

The reference complex is gray, and the real-time complex is amber or green, depending on your color setup.

Turn ST On and Off

To turn ST analysis on, select the *ST ANALYSIS* option from the ECG menu. Your software package determines what action occurs.

With the Basic software package, selecting *ST ANALYSIS* is a direct action option that turns the program on and off. When on, ST values are displayed under each ECG lead label. The lead with the greatest deviation and its value are displayed in the ECG parameter window. If your monitor defaults are configured with ST as parameter 2, values for all leads are displayed in the ECG parameter window.

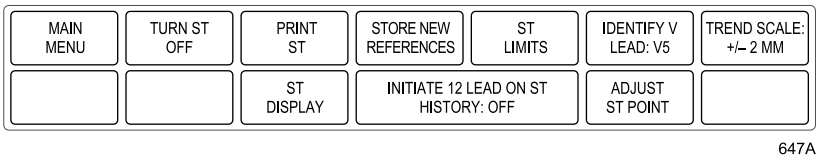
With the Cardiac software package, selecting the *ST ANALYSIS* option turns on the program and displays the ST menu. See the ST Analysis Menu section below for more details.

ST Analysis Menu

NOTE

This option is part of the Cardiac software package.

In the Cardiac software package, a new menu is displayed when *ST ANALYSIS* is turned on. ST trends and complexes may also be displayed (see above).



ST Analysis Menu

- *TURN ST OFF* — Turns ST analysis off and returns to the main menu.
- *PRINT ST* — Prints a copy of the displayed ST trends and complexes.
- *STORE NEW REFERENCES* — Displays a new set of reference complexes on the screen to use for visual references.
- *ST LIMITS* — Displays a menu and information window to set and adjust ST deviation limits.
- *IDENTIFY V LEAD* — Identifies or labels the V lead being used for ECG and ST analysis.
- *TREND SCALE* — Selects another scale for the ST trends.

- *ST DISPLAY* — Changes the leads for the trends and complexes display.
- *INITIATE 12 LEAD ON ST HISTORY* — Allows or disallows the initiation of an automatic 12 lead analysis when an ST event is stored in history.
- *ADJUST ST POINT* — Adjusts the measurement point for ST.

Print ST

Select the *PRINT ST* option from the ST menu to print a copy of the real-time trends and the real-time complexes. The reference complexes are not printed. The trend is printed first, with the appropriate lead complex immediately following it. The lead label appears on the trend, and the ST value appears at the end of the lead complex. Invalid data is represented by a "buzz" line. The ST data is sent to the writer designated as the print window location.

NOTE

Trends displayed on a 2- or 4-mm scale print on a 3-mm scale. Trends displayed on a 6- or 8-mm scales print on a 6-mm scales.

Store New References

If you want to update the reference complexes shown on the display so they reflect current complexes, select the *STORE NEW REFERENCES* option from the ST menu. A popup menu opens, with *YES* and *NO* options.

Select *YES* if you are sure you want to replace the reference complexes. The current complexes become the reference complexes. An ST reference history is created and can be viewed in alarm history.

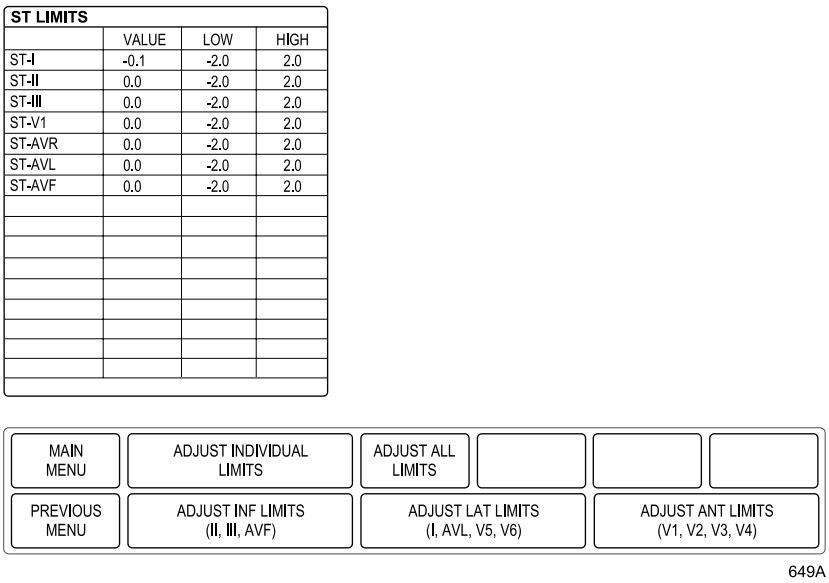
NOTE

Selecting *STORE NEW REFERENCES* does not affect actual ST processing. It is for visual reference only.

ST Limits

The ST Limits option provides an information window and a new set of menu options. The information lists all leads monitored, the current value of each, and the low and high ST alarm limit values. ST is treated as a parameter; therefore, to change the alarm level use the parameter alarm level option in the Alarm Control menu.

Below is an example of an ST Limits information window when monitoring ST with a 5-leadwire ECG cable. The factory default limits are ± 2 mm, with the ST parameter set for an advisory alarm.



ST Limits Menu and Information Window

When set to factory defaults, if any monitored lead has a deviation of more than 2 mm, an alarm sounds and the event is stored in alarm history. The alarm level must be set for crisis, warning, or advisory for the event to be stored in history.

ST Alarm History Criteria

Not every alarm is stored in history. The first lead in each group (anterior, inferior, lateral) that exceeds a limit triggers an ST history. Subsequent limit alarms in the same group do not trigger an ST history. If all available leads in a group return to within the set limits, and then any lead in that group exceeds a limit, another ST history is stored.

Refer to the Alarm History section in Chapter 10, Patient Data, for information on viewing an ST event that has been stored in history.

Adjusting ST Limits

You can adjust ST limits individually, all at once, or by lead group.

The *ADJUST INDIVIDUAL LIMITS* option allows you to adjust each lead and limit individually.

1. Select the lead label you wish to change.
2. Highlight the high or low limit.
3. Change the limit value.
4. Press the Trim Knob control to complete the change. The new limit takes effect immediately.
5. Rotate the Trim Knob control to highlight the lead label, then press it to unhighlight. You can now move to another lead if you want.

NOTE

Steps 4 and 5 are not needed when using the optional touchscreen. Simply use the touchscreen arrows to move around the information window.

6. When you are finished making changes, select *RETURN* to close the information window.

The other adjust options, *ADJUST ALL LIMITS*, *ADJUST INF LIMITS*, *ADJUST LAT LIMITS*, and *ADJUST ANT LIMITS*, adjust all leads or specific groups of leads.

When you select one of these options, a popup menu opens. The popup menu displays a deviation range, for example, *+/– 2mm*. You can change this value.

When you exit the popup menu, the monitor adjusts the low and high limits around the current value of the lead(s). For example, if lead II has a value of –0.3mm and the popup menu shows a deviation range of *+/–2mm*, the monitor adjusts the low limit to –2.3mm and the high limit to 1.7mm.

The Adjust popup menus serve two purposes:

- Selecting causes an automatic adjustment of the limits on a group of leads, based on the deviation range displayed in popup menu and the current ST value for each lead in the group.
- The deviation range can be changed to tighten or loosen the limits.

Identify V Lead

Select the *IDENTIFY V LEAD* option to open a popup menu. Its function varies depending on whether you are using a 5-leadwire cable or a 10-leadwire cable (see below).

Select the V lead name of choice. Press the Trim Knob control or touch the *IDENTIFY V LEAD* option to confirm the change and close the popup menu.

NOTE

Changing the V lead affects the displayed V waveform, analog output, the information sent over the network (Holter, MARS, central station), the ST trend and template, graphing, and histories.

Identify V Lead Option with a 5-Leadwire Cable

With a standard, 5-leadwire patient cable, this menu option labels the V lead as placed in your electrode configuration. This V lead is used in ST analysis as well as arrhythmia analysis. With a 5-leadwire cable you only connect one V lead, therefore, you must place the electrode in the V position you want, and then be certain that the label matches the position. The monitor default is V5, but it can be changed here or in monitor defaults (*ST V LEAD*). If ST trends and complexes are displayed, changing this label changes the label on the V lead trend and complex.

Identify V Lead Option with a 10-Leadwire Cable

With a 10-leadwire patient cable and all V leads attached to the patient, ST measurements are performed on all V leads. However, the arrhythmia analysis program only uses one V lead. It is identified here. Changes made with the *IDENTIFY V LEAD* option only affect the V lead used for arrhythmia analysis. The monitor default for this option is V5, but it can be changed here or in monitor defaults (*ST V LEAD*). If you are displaying ST trends and complexes, using this option does not change the label on the ST display. Use the ST display option to change the label.

Trend Scale

The *TREND SCALE* option opens a popup menu with alternative scale choices for real-time ST trends. The popup menu options are: *+/–8 MM*, *+/–6 MM*, *+/–4 MM*, and *+/–2 MM*. Use the Trim Knob control or touchscreen to make your selection and close the popup menu.

NOTE

Trends displayed on a 2- or 4-mm scale print on a 3-mm scale. Trends displayed on a 6- or 8-mm scale print on a 6-mm scale.

ST Display

The *ST DISPLAY* option opens a popup menu in which you can choose up to three leads for the ST trends and complexes display. Options for a 5-leadwire patient cable are: *I, II, III,* the lead chosen in *IDENTIFY V LEAD*, *AVR, AVL, AVF*. Options for a 10-leadwire patient cable are: *I, II, III, V1, V2, V3, V4, V5, V6, AVR, AVL, AVF*. The monitor defaults are leads *I, II,* and *V5*.

You are allowed three choices. You must deselect one to select another.

NOTE

When the monitor is set up for Operating Room mode, the trends portion of the ST display is slightly different. The third ST display choice is replaced with a summary (*SUM*) trend of all leads.

Initiate 12 Lead on ST History

This direct action menu option enables or disables initiation of an automatic 12-lead ECG analysis whenever an ST alarm is stored in alarm history. Refer to the ST Limits section in this chapter for criteria for storage of an ST alarm.

Adjust ST Point

The *ADJUST ST POINT* option opens a popup menu to allow you to adjust the measurement point for ST. The options are: *J + 0MS, J + 30MS, J + 40MS, J + 50MS, J + 60MS, J + 80MS*.

Select the desired measurement point and close the popup menu. The selected measurement point will be displayed in the parameter window.

ECG Filter

Select *ECG FILTER* to open a popup menu with choices for filtering the ECG waveform data on the display and graph strip.

NOTE

Filters affect the ECG waveform only. ST analysis and arrhythmia analysis are not affected by filter choices.

NOTE

The ECG filter mode cannot be changed when using a 10-lead cable.

- *DIAGNOSTIC* — Provides the least amount of filtering (.05-120 Hz).
- *MONITORING* — Recommended for typical monitoring applications (.05-40 Hz).
- *MODERATE* — Used to reduce high frequency interference, i.e., ESU (.05-25 Hz). Moderate ECG filtering is not recommended for pacemaker patients.
- *MAXIMUM* — Provides maximum filtering (5-25 Hz); used to stabilize the ECG baseline. Maximum ECG filtering is not recommended for pacemaker patients.
- *HELP* — Provides additional ECG filter information.

WARNING

The *MAXIMUM* filter alters the displayed ECG morphology. Do not rely on ECG morphology for diagnostic purposes when this filter is selected. When selected, "*5 Hz*" is displayed under the ECG parameter label.

12 Lead ECG Analysis

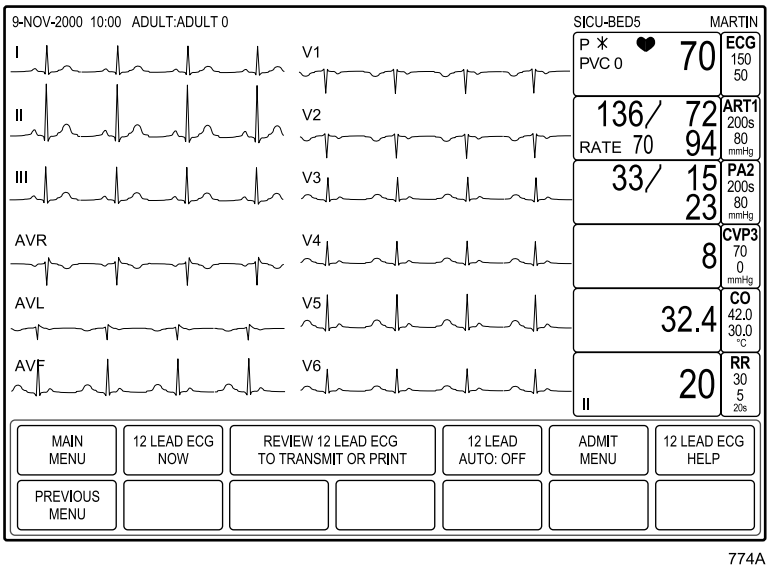
NOTE
This feature is only available when using a Tram x51 series module or a Tram “SL” module.

WARNINGS
This device uses a computerized 12-lead ECG analysis program, which can be used as a tool in ECG tracing interpretation. This computerized interpretation is only significant when used in conjunction with clinical findings. All computer-generated tracings should be overread by a qualified physician.

To ensure accuracy, use only computer-generated tracings and not the display for physician interpretation.

The intended use of this device is to record electrocardiograms and vectorcardiograms from surface ECG electrodes, not for positioning (floating) temporary pacemaker leadwires, performing pericardiocentesis, or other internal applications.

Select the *12 LEAD ECG ANALYSIS* option from the ECG menu. A new menu is displayed, and the screen is reconfigured to display 12 leads of ECG.



12-Lead Analysis Display

All parameters continue to be monitored, and values are displayed in their respective parameter windows.

The 12-lead analysis menu options are:

- *12 LEAD ECG NOW* — Opens an information window in which you can enter the *TECHNICIAN ID*, *OPTION FIELD*, and *ORDER NUMBER*.
  - *TECHNICIAN ID* — Opens a popup menu to enter up to four digits for the technician's ID number.

    NOTE

    This option can be set to *MANDATORY* or *OPTIONAL* in the Setup Display Defaults window. If it is set to *MANDATORY*, a manual 12-lead analysis cannot be taken until an ID number is entered. The factory default setting is *OPTIONAL*.

  - *OPTION FIELD* — Opens a popup menu in which you can enter a two-digit option number.
  - *ORDER NUMBER* — Opens a popup menu in which you can enter up to nine digits for the order number.
  - *RETURN* — Selecting *RETURN* initiates one 12-lead ECG analysis.
- *REVIEW 12 LEAD ECG TO TRANSMIT OR PRINT* — Opens a popup menu to transmit, print, or delete the analysis. The last analysis is available to print until another 12-lead analysis is generated. Transmission of a 12-lead report is only allowed once.
- *12 LEAD AUTO* — Opens a popup menu to program the monitor to automatically do 12-lead ECG analysis at specified time intervals. (A MUSE system is required for automatic printing and storage, or a local laser printer is required for automatic printing without a MUSE system.)
- *ADMIT MENU* — Opens an information window to enter or change patient information (name, age, ID, etc.).
- *12 LEAD ECG HELP* — Displays an information window with a summary of the process for 12-lead ECG analysis, along with a popup menu containing selections for additional 12-lead analysis help, including skin prep and lead placement.

Manual Method

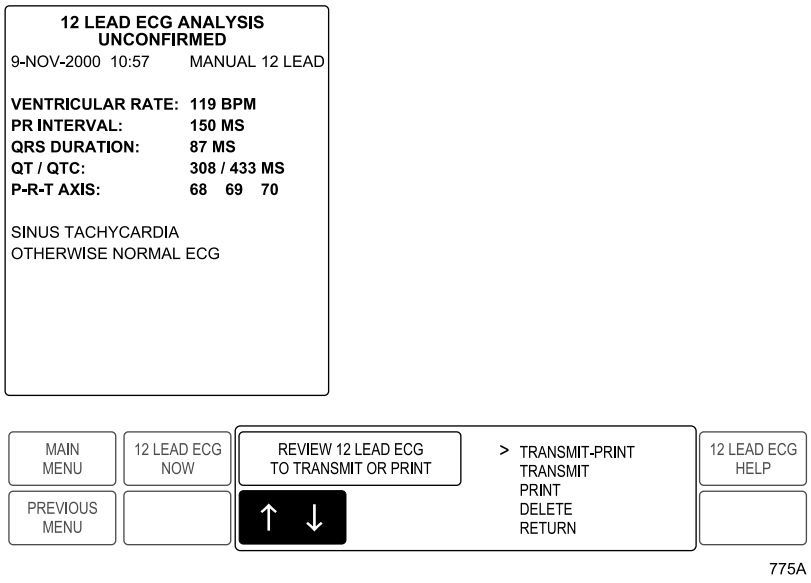
To obtain a 12-lead analysis manually, follow these steps:

1. Select *12 LEAD ECG ANALYSIS* from the ECG menu. The waveform area of the screen displays 12 leads of ECG.
2. Use the *ADMIT MENU* option to:
   - Enter the patient's age and identification number.
   - Enter the location number if your hospital has a MUSE system. The location number identifies the care unit where the system is located.

   This information may already have been entered when the patient was admitted to the monitor.
3. Select *12 LEAD ECG NOW* from the 12 Lead ECG Analysis menu. An information window opens, from which you can enter *TECHNICIAN ID*, *ORDER NUMBER*, and *OPTION FIELD* information.

   NOTE

   The *TECHNICIAN ID* option can be set to *MANDATORY* or *OPTIONAL* in the Setup Display Defaults window. If it is set to *MANDATORY*, a manual 12-lead analysis cannot be taken until an ID number is entered. The factory default setting is *OPTIONAL*.
4. After you have entered the information in these fields, select RETURN. The message "*Performing Analysis. Please wait...*" is displayed on the screen. In approximately 30 seconds, the analysis report is displayed, along with a popup menu.



Analysis Report and Popup Menu

5. To continue, choose one of the four options from the popup menu:
   - *TRANSMIT-PRINT* — Sends the analysis to the MUSE system. Printing occurs at the local writer or laser printer that was selected as the 12-lead print location or the print window location.
   - *TRANSMIT* — Sends the analysis to the MUSE system for storage.
   - *PRINT* — Sends the analysis to the 12-lead print location or the print window location. If it is a laser printer, the analysis and waveforms print. If it is a writer, only the analysis prints.
   - *DELETE* — Erases the analysis without storing or printing.
   - *RETURN* — Returns to the 12-lead analysis display.

   The popup menu closes after you make your selection.

Automatic Method

This option automatically generates a 12-lead ECG analysis at set intervals and automatically sends it to a MUSE system and/or a laser printer. Once the interval is set, you can resume customary monitoring and let the monitor do the 12-lead analysis.

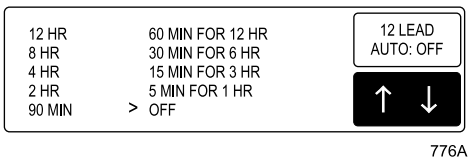
NOTE

This method requires a MUSE system for automatic storage and printing. If a laser printer is designated as the 12-lead print location or the print window location, the analysis automatically prints there also.

1. Select *12 LEAD ECG ANALYSIS* from the ECG menu. The waveform area of the screen displays 12 leads of ECG.
2. Use the *ADMIT MENU* option to:
   - Enter the patient's age and identification number.
   - Enter the location number if your hospital has a MUSE system. The location number identifies the care unit where the system is located.

   This information may already have been entered when the patient was admitted to the monitor.

3. Select the *12 LEAD AUTO* option from the 12 Lead ECG Analysis menu. A popup menu opens, showing the time interval selections.



12 Lead Auto Popup Menu

4. Move the pointer to the desired time interval.

   A first-column choice (*12 HR* to *90 MIN*) means one analysis is done every X hours (minutes) until you turn it off.

   A second-column choice means one analysis is done every X minutes for X hours, and then it turns off automatically.

   Select *OFF* at any time to turn off 12-lead analysis.

   NOTE

   You can do a manual analysis in between scheduled automatic analyses without interrupting the sequence.

5. Press the Trim Knob control or touch the *12 LEAD AUTO* option to make the selection. The first analysis begins immediately.

Lead Analysis

With the lead analysis option, you can choose single lead analysis or multi-lead analysis for ECG and arrhythmia analysis.

Multi-Lead Analysis

Multi-lead analysis examines ECG leads I, II, III, and the V lead (whether they are displayed or not) to help eliminate false alarms and improve the ability of the system to:

- Detect beats that occur isoelectric to a single chest lead.
- Discriminate artifact that appears in one lead compared to the other lead vectors.
- Provide a “smart-lead fail” feature, where the failed lead is identified, and, if available, another lead is provided for display.
- Continue arrhythmia processing even after a lead change.

Single Lead Analysis

Single lead analysis uses only the lead displayed in the top position on the screen to process ECG and arrhythmia information.

When monitoring an adult, single lead analysis is beneficial when:

- Using an external, temporary pacemaker with a Zoll interface cable.
- Troubleshooting pacemaker detection and/or arrhythmia detection.

Changing Lead Analysis

To change lead analysis, select *LD ANALYSIS* from the ECG menu. A popup menu opens, displaying two options: *SINGLE LEAD* and *MULTI-LEAD*.

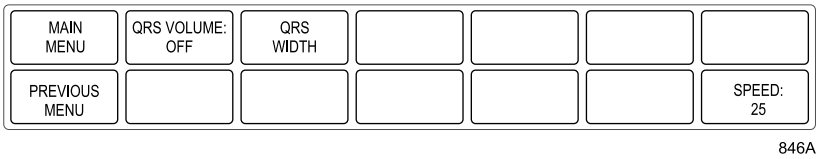
Select the desired option and close the popup menu.

NOTE
ECG is relearned whenever lead analysis is changed.

NOTE
Because of the lead configuration used when monitoring neonates, single-lead analysis defaults on, with lead II in the top trace position when the monitor is set up for Neonatal-ICU mode.

More ECG

The *MORE ECG* option opens a menu with additional ECG options.



More ECG Menu

QRS Volume

The QRS Volume option adjusts the tone that sounds each time a QRS complex is detected.

NOTE

QRS Volume is not available when monitoring ECG from a telemetry transmitter.

1. Select *QRS VOLUME* from the ECG menu. A popup menu opens, displaying the volume choices.
2. Rotate the Trim Knob control or use the touchscreen arrows to change the volume. You will hear a tone at each volume.
3. When you are satisfied with the volume level, press the Trim Knob control or touch the *QRS VOLUME* option to close the popup menu.

NOTE

Turning QRS Volume on automatically turns SPO2 Rate Volume off, if it was on (refer to Chapter 14, SPO2).

When in Neonatal-ICU or Operating Room mode, the 10% and 20% volume tones are slightly quieter than they are in the Adult-ICU mode.

QRS Tone with Brady Alarm

This feature is only found in the Neonatal-ICU mode. With this feature, the QRS tone automatically starts when the monitor alarms for bradycardia. The QRS tone will stop when the bradycardia alarm stops.

NOTE

The QRS tone for this feature is 20% louder than the set alarm volume.

During an alarm pause, the QRS tone does not sound, just like any other alarm tone. The QRS tone can be silenced with the **Silence Alarm** button.

To enable this feature, select *QRS VOLUME* from the More ECG menu. Select *BRADY ALARM* from the QRS Volume popup menu. The monitor must be set for the Neonatal-ICU mode for the Brady alarm option to appear.

The factory default for this feature is off. To set the default to on, refer to the Setup Defaults Display section in Chapter 5, Monitor Defaults.

NOTE

Turning SPO2 Rate Volume on turns the QRS Tone with Brady Alarm feature off.

QRS Width

The QRS Width option opens a popup menu to specify the QRS width as *NORMAL* or *NARROW*. The selected width is sent to the Tram module for use in ECG analysis algorithms.

The *HELP* option opens an information window containing information regarding the width types.

The QRS width type defaults to Narrow for the Neonatal-ICU mode, and to Normal for Adult-ICU and Operating Room modes. QRS width type can be set in monitor defaults.

NOTE

A Tram module with software version 9 or later is required to read the QRS width setting and apply the information to the ECG analysis algorithms.

Speed

This option opens a popup menu to select a sweep speed for all displayed ECG waveforms. Choices are 6.25, 12.5, 25, and 50 millimeters per second. The default is 25 mm/sec.

NOTE

Speeds of 50 mm/sec and 6.25 mm/sec are not possible when only ECG waveforms are displayed.

Troubleshooting

Problem:
Inaccurate heart rate and/or false asystole

Solution:

Check ECG signal from patient:

1. Check/adjust lead placement.
2. Check/perform skin preparation.
3. Check/replace electrodes.

Check amplitude of ECG waveform:

1. Select *ECG* parameter label.
2. Select *DISPLAY LEAD*.
3. Scroll through all ECG leads and check for 0.5 mV amplitude at normal (1X) size. (At least 0.5 mV amplitude is required for QRS detection.) For borderline signals, validate on a graph.
4. If amplitudes are low, electrodes may need to be repositioned or replaced.

Relearn arrhythmia:

1. Select *ECG* parameter label.
2. Select *RELEARN*.

IF PROBLEM CONTINUES AND ECG AMPLITUDE IS LOW:

1. Select *ECG* parameter label.
2. Select *ECG SIZE*.
3. Select *2X* or higher.
4. Close the popup menu.
5. Select *RELEARN*.

IF PROBLEM CONTINUES: Change to single lead ECG detection and processing:

1. Select *ECG* parameter label.
2. Select *LD ANALYSIS*.
3. Select *SINGLE LEAD*.
4. Select *DISPLAY LEAD*.
5. Assess all the ECG leads and change top ECG waveform to display lead with greatest amplitude. (At least 0.5 mV amplitude is required for QRS detection.)

Problem:
False ventricular calls

Solution:

Check ECG signal from patient: (The chest lead may exhibit polarity changes which may occasionally cause an inaccurate call.)

1. Check/adjust electrode placement.
2. Check/perform skin preparation.
3. Check/replace electrodes. (If the chest lead is a problem, move the chest lead to another chest position or leg position.)
4. Relearn ECG:
   a. Select *ECG* parameter label.
   b. Select *RELEARN*.

IF PROBLEM CONTINUES:

1. Select *ECG* parameter label.
2. Select *RELEARN*.

Problem:
ST numerics displayed only for primary (top) lead

Solution:

Check whether single lead or multi-lead processing is selected. Numerics will only be displayed for the primary lead if single lead processing is active.

Problem:
ST measurement points for ISO or J are incorrect.

Solution:

1. Relearn ECG:
   a. Select *ECG* parameter label.
   b. Select *RELEARN*.
2. Adjust ST measurement point:
   a. Select *ECG* parameter label.
   b. Select *ST ANALYSIS* from ECG menu.
   c. Select *ADJUST ST POINT*.

Pacemaker Troubleshooting

There are two general things that occur when the pace mode is activated for pacemaker patients:

1. Beats that would otherwise be classified as ventricular are instead classified as V-paced if a ventricular pacemaker event is detected.
2. Residual pacemaker energy that might otherwise appear in the ECG is removed, and a “pacemaker enhancement spike” is artificially placed in the ECG.

Pace detection is indicated visually in the ECG parameter box. By watching the ECG waveform, pace detection is indicated by uniform, upright pacemaker enhancement spikes in the ECG data (both displayed and graphed).

The pacemaker signal is acquired from the displayed ECG lead (top trace).

Two effective approaches for improving pacemaker detection are:

- Change the displayed ECG trace to a different lead.
- Move the electrodes associated with the displayed trace.

Problem:
Inaccurate pacemaker detection

Solution:

Use pacemaker processing:

1. Select *ECG* parameter label.
2. Display the ECG lead with the greatest amplitude in the top waveform position.
3. Select *DETECT PACE*.
4. Select *PACE 2* or *PACE 1*.

NOTES:

- In general, be aware that a pacemaker pulse could be falsely counted as a QRS during asystole.
- *PACE 1* pace mode analyzes the presence of a pacer spike, assesses the waveform for residual pacemaker energy, and determines the presence of an R wave following the pacer spike. If an event occurs during the first few milliseconds following the pacer spike, it will be counted.
- *PACE 2* pace mode analyzes waveforms with the added capability of minimizing the chance of counting severe residual pacemaker energy as QRS complexes. In relation to the event rejection capability of *PACE 2* pace mode, certain morphologies may not be detected. Arrhythmia calls like asystole or pause may be made with heart rate identified as less than actual.

Again, ***pacemaker patients should be kept under close observation.*** The appropriate pace mode may be determined at the time the pacemaker patient is admitted to the monitoring system. The *Pace 2* mode is recommended for use whenever possible.

Check ECG signal from patient:

1. Check/adjust lead placement; refer to the Electrode Placement for Pacemaker Patients section in this chapter.
2. Check/perform skin preparation.
3. Check/replace electrodes.

For your notes

12 Pressures

For your notes

Introduction

Invasive pressure monitoring can be done with the following acquisition modules:

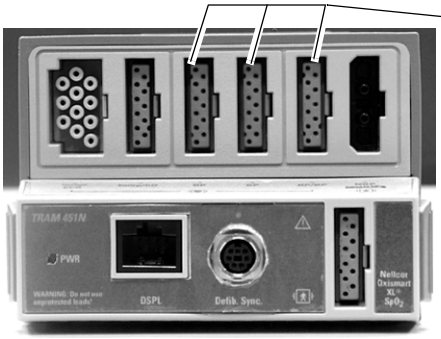
- A Tram module that supports pressures
- BP module
- Dual BP module
- BP/Dual temperature module
- BP/CO module

NOTE

Waveforms from modules other than a Tram module are not stored in history. These modules must be seated in one of the bottom two slots of a Tram-rac 4A housing.

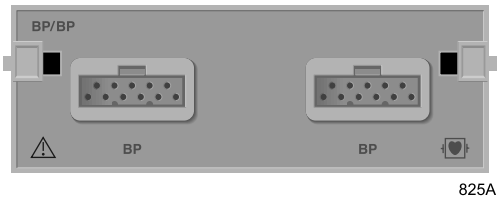
The BP/CO module must be used with a Solar ECG/Resp module.

A maximum of six invasive pressures can be monitored at any one time.



Tram 451N Module

BP Module



Dual BP Module

NOTE

The signal input is a high-insulation port and it is defibrillator-proof ( ).

The insulated input ensures patient safety and protects the device during defibrillation and electrosurgery.

Assigned BP Names

Each invasive pressure connector on the module is labeled **BP**. For convenience, the monitor has a specific pressure name assigned to each **BP** connector. These names can be changed during setup, so any pressure line can be plugged into any **BP** connector. Having the **BP** connector names properly reflect the sites is important for proper waveform processing, since different algorithms are used for processing different pressure sites.

The site names supported and values displayed are:

- arterial (ART) — systolic, diastolic, and mean
- femoral (FEM) — systolic, diastolic, and mean
- pulmonary artery (PA) — systolic, diastolic, and mean
- central venous (CVP) — mean
- left atrial (LA) — mean
- right atrial (RA) — mean
- intracranial (ICP) — mean
- special (SP) — mean

Additional site names available in the Neonatal-ICU mode are:

- umbilical artery catheter (UAC) — systolic, diastolic, and mean
- umbilical venous catheter (UVC) — mean

The chart below shows the pressures assigned to the BP connectors on the Tram modules. For reference purposes, this manual refers to the connectors as BP1, BP2, etc., beginning with the left-most connector.

Assigned BP Names

	BP1	BP2	BP3	BP4
Tram modules with 2 BP connectors	ART	PA	—	—
Tram modules with 3 BP connectors	ART	PA	CVP	—
Tram modules with 4 BP connectors*	ART	PA	CVP	LA

*Or, fourth BP when using a Tram 451 series module with the split BP3/BP4, Y-adapter cable plugged into the third BP connector.

Separate BP modules residing in the third or fourth slot of the Tram-rac housing are assigned as ICP and SP pressures.

NOTE

Pressure site names cannot be set in monitor defaults. However, upon discharge in the Operating Room mode, pressure site names remain as last selected.

The invasive pressure labels are displayed on the monitor with a number (1-8) associated with the numbers printed on the Tram-rac housing. The number identifies the location of the connector in the Tram-rac housing. For example, *ART1* and *PA2* are BP connectors on a module located in the first slot of the housing.

Zero Reference

Zeroing the pressure transducers is very important for accurate pressure measurements. Transducers should be zeroed frequently, and always before initiating treatment changes based on the pressure data. You can zero all transducers at one time, or zero each one individually.

To zero all the pressure transducers at one time, follow this procedure:

1. Close the transducer stopcock(s) to the patient.
2. Open the venting stopcock(s) to air (atmosphere).
3. Press the **Zero All** button on the keypad.
4. Verify that zero reference has been established. (Watch the pressure parameter windows for messages.)
5. Close the venting stopcock(s) to air (atmosphere).
6. Open the transducer stopcock(s) to the patient. Within seconds, pressure numerics should be displayed in the pressure parameter windows.

NOTE

Refer to the Pressure Menu Options section in this chapter for information about zeroing a single pressure transducer.

Checklist

1. The module is securely inserted in the Tram-rac housing.
2. Patient cable is attached to the **BP** connector on the module.
3. Transducers are leveled according to unit policy. (Recommended standard is level of right/left atrium.)
4. All transducers are zeroed.
5. Any entrapped air is removed from the system.

   NOTE

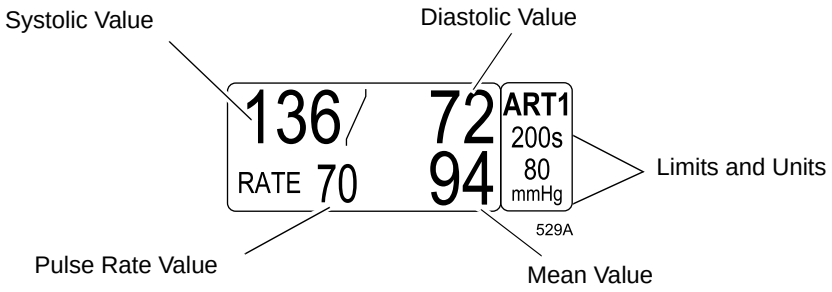
   Refer to the transducer manufacturer's instructions for suggested means of removing entrapped air from the hydraulic system.

6. Pressure setup is adjusted, if necessary. Details are provided in this chapter.

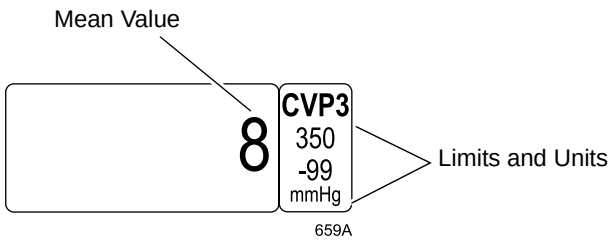
Pressure Monitoring

Pressure Information

A labeled pressure waveform is displayed when the patient cable is connected to the module. After a zero reference procedure is done, numerics are displayed in the pressure parameter windows on the right side of the screen.



ART Pressure Parameter Window



CVP Pressure Parameter Window

The current systolic, diastolic, and mean values are displayed. Some pressures only display a mean value. Limits and the units of measurement may also be displayed. For pressures with multiple values, the limits are labeled (S=systolic, D=diastolic, M=mean). For sites labeled ART, FEM, and UAC, a pulse rate value can be turned on.

The pressure monitoring features are found in the pressure menu. All pressure menus includes scales, cursor, site name, limits, zero, and calibration. There are additional options in the ART and PA menus, which are detailed in the Special Features section of this chapter.

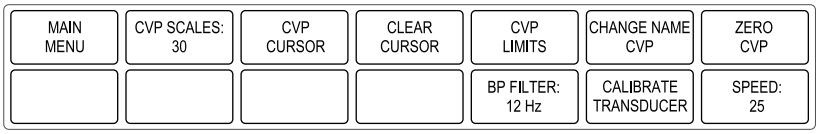
CPP Pressure

When both ART and ICP are monitored, a cerebral perfusion pressure (CPP) value is calculated and displayed in the ICP values window. The formula for this is the mean ART pressure value minus the ICP pressure value.

Getting to the Pressure Menu

To display a pressure menu, select the pressure parameter label. This example uses the CVP menu.

After selecting the *CVP* label, the CVP menu appears at the bottom of the screen.



CVP Menu

You can now select any of the displayed options:

- *SCALES* — Changes the displayed scale for this pressure.
- *CURSOR* — Displays a moveable cursor on the waveform.
- *CLEAR CURSOR* — Removes the cursor from the waveform.
- *LIMITS* — Displays a new menu and an information window to adjust alarm limits.
- *CHANGE NAME* — Changes the pressure site to another name.
- *ZERO* — Used to zero reference this transducer only.
- *BP FILTER* — Used to select a 12 or 40 Hz filter.
- *CALIBRATE TRANSDUCER* — Adjusts the transducer offset.
- *SPEED* — Changes the sweep speed for the displayed pressure waveform.

These menu options are found in all pressure menus. The only difference is the site name, for example, *CVP CURSOR*, *PA CURSOR*, etc. More details on each option are found in this chapter.

There are special features associated with ART and PA, which are explained in the Special Features section found in this chapter.

Pressure Menu Options

In most cases, the CVP parameter and menu are used to demonstrate the pressure menu options.

Scales

The Scales option allows you to change the scale on which the pressure waveform is displayed on the monitor. Changing the scale changes the size of the waveform. Scales can be set in Monitor Defaults.

1. Select *CVP SCALES* from the CVP menu. A popup menu opens, showing the scale sizes available. The scale currently being used is designated by a pointer (>).

   NOTE
   AUTO is only an option once the pressure has been zeroed.

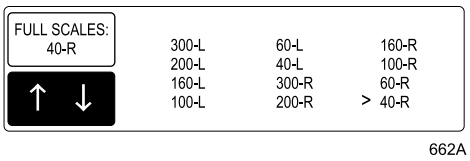
2. Select the desired scale size.

   Selecting *AUTO* calculates a scale based on the patient's current arterial blood pressure.

   NOTE
   Auto scaled waveforms graph on a slightly different scale than displayed.

Full Scales

If the waveform is on a full scale, the menu option reads *FULL SCALES*, and the popup menu looks like this example:



Full Scales Popup Menu

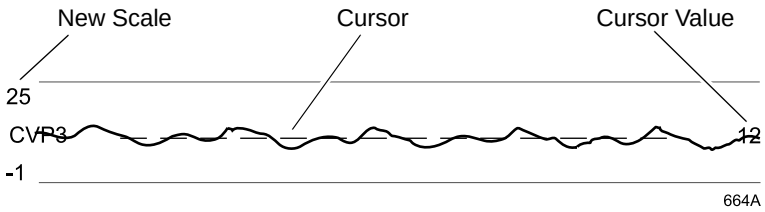
Use this popup menu to place the waveform on a right (*R*) or left (*L*) scale, as desired.

Cursor

Using this option places a cursor (dashed, horizontal line) across the pressure waveform. The cursor is moveable and is used to give accurate pressure values at selected points on the pressure waveform. A numeric value is displayed on the screen to the right of the cursor.

1. Select *CVP CURSOR* from the CVP menu. A popup menu opens.

   When displaying the pressure waveforms on individual scales, the monitor automatically calculates a scale. The new scale and cursor are displayed with the waveform.



Cursor on CVP Waveform

2. With the popup menu open, rotate the Trim Knob control or use the touchscreen arrows to move the cursor. The cursor value changes as the cursor moves.
3. Press the Trim Knob control or touch the *CVP CURSOR* option to close the popup menu. The cursor remains on the waveform.

NOTE

In the Full and Full Grid display modes, only one cursor can be displayed at a time, but it can be moved throughout the entire full scale range.

The cursor remains on the screen until you turn it off using the Clear Cursor option, change the scale size, or change the display mode. When the cursor is removed, the pressure scale returns to the scale used before the cursor was turned on.

Clear Cursor

To remove the cursor from the waveform, select the *CLEAR CURSOR* option from the pressure menu. This is a direct action menu option.

Limits

Selecting this option opens an information window and a new menu, which allow you to adjust the alarm limits for the displayed pressures (systolic, diastolic, mean, and/or rate).

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

Change Name

This option is used to change the designated name for this pressure connector. The monitor has preset names for each pressure connector, based on its location in the Tram module and Tram-rac housing. (Refer to the Assigned BP Names section in this chapter.)

Having the names properly reflect the sites is important for proper processing of the waveform, since different algorithms are used for different pressure sites.

NOTE

Pressure site names cannot be set in monitor defaults; however, upon discharge, pressure site names remain as last selected.

To change a name, select the *CHANGE NAME* option from the pressure menu. A popup menu opens, listing all the choices. The name presently assigned is designated with the pointer (>).

Select the desired name and close the popup menu. This causes a change in the parameter window and the main menu is displayed.

Zero

Use the *ZERO* option to zero this transducer only.

1. Close the transducer stopcock to the patient.
2. Open the venting stopcock to air (atmosphere).
3. Select the *ZERO* option in the pressure menu.
4. Verify that zero reference has been established. (Watch the pressure parameter window messages.)
5. Close the venting stopcock to air (atmosphere).
6. Open the transducer stopcock to the patient. Within seconds, pressure numerics should be displayed in the pressure parameter window.

BP Filter

Select the *BP FILTER* option to open a popup menu from which you can select a 12 or 40 Hz filter.

The 12-Hz Filter is recommended for typical monitoring applications. The 40-Hz Filter allows higher frequency waveform components to be processed. This may result in elevated pressure values.

This menu also offers a Help option, which opens an information window that provides additional information about BP filters.

Calibrate Transducer

The Calibrate Transducer option allows you to adjust the monitor for any transducer error.

NOTE

Error is determined when pressure calibration is measured with another instrument such as a mercury manometer.

Select the *CALIBRATE TRANSDUCER* option from the pressure menu. A new menu is displayed, with two options. Select one of the two menu options. Adjusting one option automatically adjusts the other.

- *CAL # 100* — Opens a popup menu to enter the percentage of error. Use this option when the calibration error is already known.

  NOTE

  Always make sure that the *CAL #* is at 100 when making a new adjustment.

  For example, if it is known that the transducer measures 2% high, enter 102. When you close the popup menu, the monitor compensates for the error.

  Or, if you apply a known pressure, such as 100, and the monitor displays 102 for that pressure site, adjust the *CAL #* to the number displayed.

  NOTE

  You must close the popup menu before a change is displayed in the values window.

- *ADJUST TO MMHG* — Opens a popup menu to change the millimeters of mercury error.

Speed

Use this menu option to open a popup menu to select a sweep speed for all displayed pressure waveforms. Choices are 6.25, 12.5, 25, and 50 millimeters per second. The default is 25 mm/sec.

Special Features

The features described in this section are not common to all pressures. Some of these features are only available with certain software packages, as noted.

IABP

NOTE
This option is part of the Cardiopulmonary software package.

NOTE
The IABP feature is NOT available when the monitor is set for the Neonatal-ICU mode.

Triggering

IMPORTANT — GE Medical Systems *Information Technologies* recommends that the signal source used to trigger an intra-aortic balloon pump should be the balloon pump itself. This insures that the trigger signal is compatible with all modes of the IABP. An extra set of ECG electrodes or an additional connection from the arterial line can be connected to the monitor to produce waveforms on the monitor's display for consolidated waveform viewing.

WARNING
PATIENT HAZARD — If you choose to trigger the balloon pump from the monitor, contact the balloon pump manufacturer directly for interface requirements, as they vary among manufacturers. ***Some trigger modes on certain balloon pump devices may not be compatible with GE Medical Systems Information Technologies' analog output signal, and use may contribute to patient injury or sub-optimal pumping results.***

If you choose to use the monitor for triggering, you must follow the instructions below. Failure to follow these instructions may result in an incompatible analog output signal, which may contribute to patient injury.

1. **Contact the balloon pump manufacturer for interface requirements.** GE Medical Systems *Information Technologies*' ECG analog output delay specification is shown in the table below.

Product	Maximum ECG Analog Output Delay Spec with Diagnostic ECG Filter*
Tram module	less than 25 milliseconds
ECG module	less than 25 milliseconds

** Refer to Step 2*

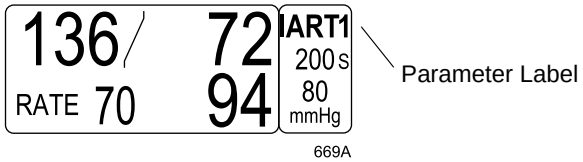
2. **Cable connection and ECG filter.**
   - Use the appropriate compatible analog output cable from GE Medical Systems *Information Technologies*.
   - Cable the balloon pump to the monitor through the **DEFIB SYNC** connector on the Tram module or the ECG module.
3. **Primary displayed ECG lead.** If the balloon pump triggers off the P wave of the QRS complex, review the patient's ECG leads and place the one with the greatest amplitude in the top (primary) position on the monitor's screen.
4. **Pacemaker Detection.** If the patient has a pacemaker, be sure pacemaker detection is on (selected from the ECG menu). Failure to turn pacemaker detection ON may cause poor beat detection, which may result in inadequate triggering of the balloon pump.
5. **BP Filter.** If blood pressure is used to trigger the balloon pump, use the 40 Hz pressure filter (selected from the pressure menu).

Using the IABP Feature

The monitor measures arterial (femoral) pressure and displays both the pressure waveform and numerical pressure values. The IABP feature compensates for the irregularities in the pressure waveform caused by the use of an intra-aortic balloon pump.

Starting the IABP Program

To turn the IABP program on and off, select the *IABP* option from the pressure menu. When on, the parameter label begins with an "I", as shown in the figure below.



ART Parameter Label with IABP On

Displayed Values

Displayed pressure values are affected by the intra-aortic balloon pump.

The IABP program displays three values, for example 150 / 45 (98). The first value, systolic, is the highest pressure in one cardiac cycle; the second, diastolic, is the lowest pressure in one cardiac cycle; and the third (mean) is the average pressure during one cardiac cycle.

The displayed numerical values are computing a rapidly varying waveform generated during IABP treatment and do not always reflect a true arterial pressure. For accuracy and reliability, always combine two or more of the recommended methods listed below for reading arterial and/or femoral blood pressure:

- the IABP waveform displayed on the screen (use scales for evaluation),
- a printed copy of the waveform (use scales for evaluation), or
- the balloon pump display, if available.

Since there are a number of points along the IABP waveform that could be the displayed value, it is important for you to know which ones the program chooses. The values displayed will differ depending on the timing of the pump.

For 1:1 or 1:2 Timing:

Systolic Numerics

- When the augmented diastole is greater that the patient systole, the displayed systole equals the augmented diastole. (See figure 1.)
- When the patient systole is greater than the augmented diastole, the displayed systole equals the patient systole. (See figure 2.)

Diastolic Numerics

- The displayed diastole always equals the balloon end diastole. (See figures below.)

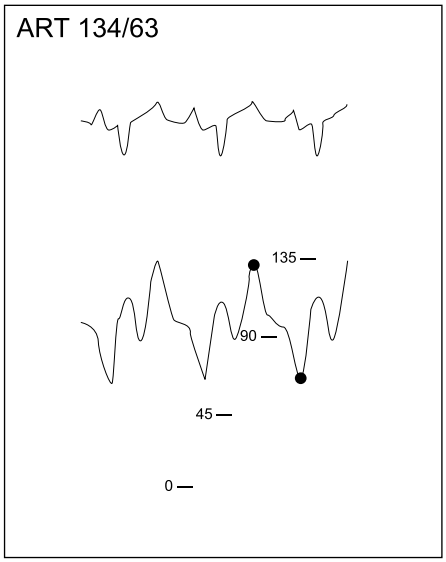


Figure 1
Augmented Diastole > Patient Systole

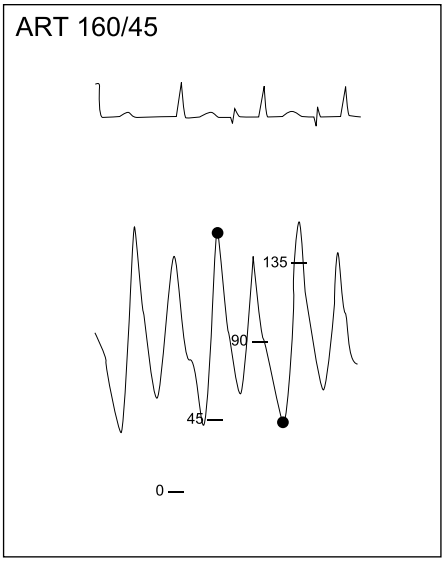


Figure 2
Patient Systole > Augmented Diastole

For 1:3 or More Timing:

Systolic Numerics

- The displayed systolic numerics switch between the augmented diastole and patient systole. (See figure 3.)

Diastolic Numerics

- The displayed diastole switches between the balloon end diastole and the patient end diastole. (See figure 3.)

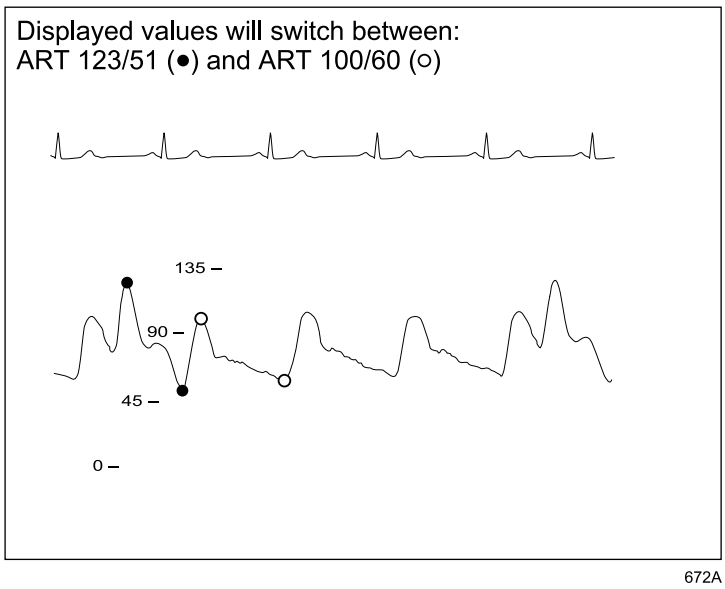


Figure 3

Smart BP

Smart BP is a feature found in ART and FEM pressure menus.

NOTE

The Smart BP feature is not available when the monitor is set for Neonatal-ICU mode.

Smart BP is an arterial (femoral) artifact rejection program that substantially reduces the occurrences of needless alarms by eliminating most of the alarms associated with zeroing the transducer, fast flushing the system, and drawing blood.

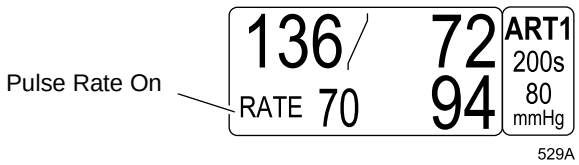
When Smart BP is on and the system recognizes one of these events, the arterial (femoral) alarms are deactivated and the systolic and diastolic numerics are replaced with Xs. The message "*ARTIFACT*" is displayed. The mean pressure value is displayed throughout the artifact occurrence.

Safety Features: If zeroing, fast flushing, or drawing blood is not accomplished within certain time frames, alarms will sound. When artifact is detected, Smart BP begins to search for the return of a pulsatile pressure. When 15-20 beats have been detected, numerics are displayed and alarms are reactivated. If pressure remains below 10 mmHg for more than 14 seconds, the alarms will reactivate. During sustained high pressure (drawing blood), you have a maximum of two minutes before alarms reactivate.

To turn Smart BP on or off, select the *SMART BP* option from the pressure menu. This feature can be set in monitor defaults.

Pulse Rate

The Pulse Rate feature is found in the ART, FEM, and UAC (neonatal mode only) pressure sites. When turned on, a rate value is displayed in the appropriate parameter values window.



Pulse Rate Displayed in ART Parameter Window

To turn the pulse rate value on and off, select *PULSE RATE* in the applicable pressure menu. This is a direct action menu option. This feature can be set in monitor defaults.

Disconnect Alarm

The Disconnect Alarm feature is found in the ART and FEM pressure menus.

NOTE

This feature is not available when the monitor is set for Neonatal-ICU mode.

If the mean pressure falls below 25 mmHg and the disconnect alarm feature is on, a warning alarm sounds and the message "*DISCONNECTED*" is displayed in the values window. The parameter name also appears in this message. Check your patient immediately in the event the catheter has dislodged.

To turn this feature on and off, select *DISCONNECT ALARM* from the appropriate pressure menu. This feature can be set in monitor defaults. The alarm level cannot be changed — it is always a warning alarm.

PA Wedge

NOTE
This option is part of the Cardiopulmonary software package.

PA Wedge is a feature found in the PA pressure menu.

There are two menu options for doing a PA Wedge measurement — *PA WEDGE* and *PA INSERT/WEDGE*. The PA Insert/Wedge option is used to emphasize the PA waveform. It offers two additional menu options.

There are two modes for doing PA Wedge measurement, the Auto mode and the Manual mode. The Auto mode allows you to perform a measurement without having to touch the monitor after starting the program. The Manual mode overrides the Auto mode and requires additional steps at the monitor to complete the measurement.

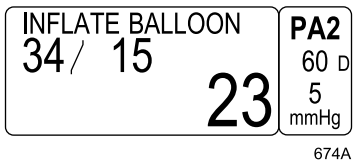
NOTE
PA Wedge is not supported when more than one PA catheter site is present.

PA Wedge Menu Option

Select *PA WEDGE* from the PA menu to start the PA Wedge program. The Auto mode defaults on.

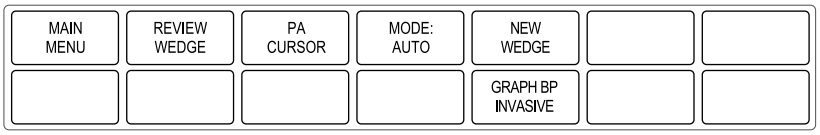
NOTE
Under certain conditions, the Manual mode may default on instead of the Auto mode. See "Auto Mode" on page 12-28 for more information.

A single beep sounds and the message "*INFLATE BALLOON*" is displayed in the PA parameter window. The program is waiting for the balloon to be inflated.



PA Parameter Windows with Prompt

A PA Wedge menu is also displayed.

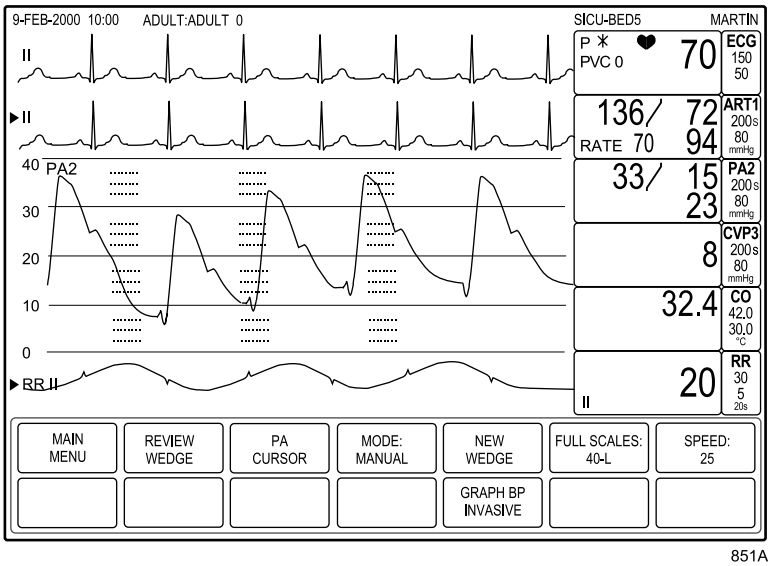


PA Wedge Menu

- *REVIEW WEDGE* — Use this option after wedging in the manual mode to review patient data.
- *PA CURSOR* — Places a moveable cursor on the real-time waveform while the wedge is being performed.
- *MODE* — Use this option to change modes (*MANUAL/AUTO*).
- *NEW WEDGE* — Use this option to restart the wedge process if dissatisfied with the previous measurement.
- *GRAPH BP INVASIVE* — Use this option to graph invasive BP waveforms.

PA Insert Wedge Menu Option

When *PA INSERT/WEDGE* is selected, the display changes to the full grid mode. All BP waveforms except the PA waveform are removed from the full grid region. CO2, Resp, ART, or FEM is displayed in the seventh waveform position if available. The PA Insert/Wedge menu is also displayed.



PA Insert/Wedge Display Mode and Menu

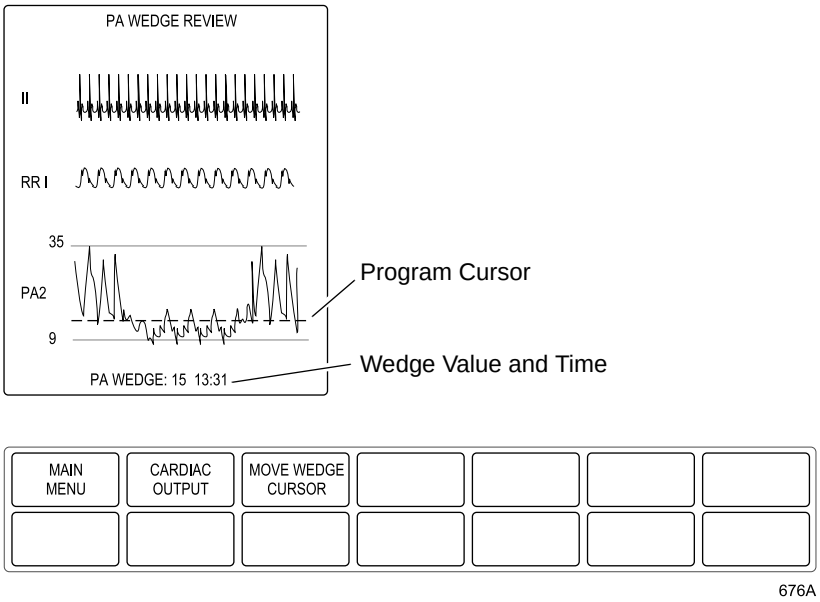
- *REVIEW WEDGE* — Use this option after wedging in the manual mode to review patient data.
- *PA CURSOR* — Places a moveable cursor on the real-time waveform while the wedge is being performed.
- *MODE* — Use this option to change modes (*MANUAL/AUTO*).
- *NEW WEDGE* — Use this option to restart the wedge process if dissatisfied with the previous measurement.
- *FULL SCALES* — Use this option to change the full grid scale for the pressure waveform.
- *SPEED* — Changes the sweep speed of the displayed PA waveform.
- *GRAPH BP INVASIVE* — Use this option to select and graph invasive BP waveforms.

Review Wedge

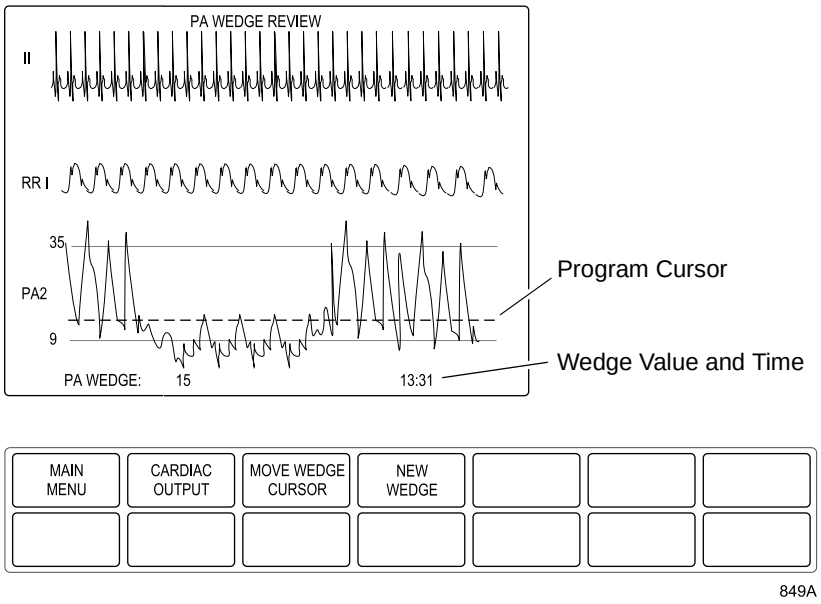
When you select *REVIEW WEDGE*, the PA Wedge Review information window appears and new menu items are displayed.

NOTE

The Review Wedge menu and information window will display automatically at the end of a PA wedge cycle when in Auto mode.



Review Wedge Menu and Information Window from the PA Wedge Menu Option



Review Wedge Menu and Information Window from the PA Insert/Wedge Menu Option

NOTE

If CO2 is being monitored, the CO2 waveform is displayed in place of the respiration waveform.

The Review Wedge menu options are:

- *CARDIAC OUTPUT* — Enters the PA wedge pressure value into Cardiac Calculations and Vital Signs. The monitor automatically enters the Cardiac Output program.
- *MOVE WEDGE CURSOR* — Repositions the cursor to change the wedge value. Refer to the Move Cursor section below.
- *NEW WEDGE* — Restarts the wedge process and returns to the PA Insert/Wedge menu. (This option is available in the Review Wedge menu from the PA Insert/Wedge option.)

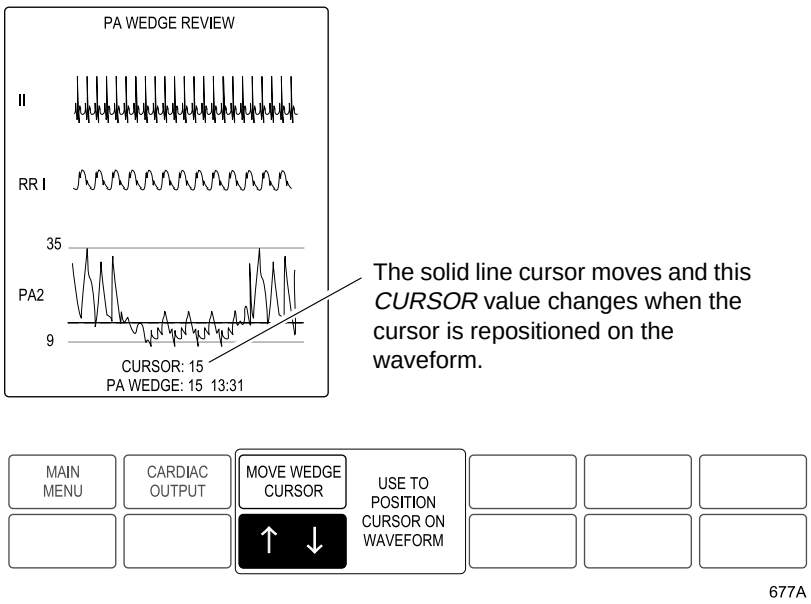
Move Wedge Cursor

If you are not satisfied with the placement of the cursor the PA wedge pressure value, you can change it.

While the PA wedge review information is displayed, select the *MOVE WEDGE CURSOR* option from the Review Wedge menu. A popup menu opens and a solid line cursor is placed on top of the dashed, program cursor in the review window.

NOTE

If you placed a cursor on the waveform during balloon inflation, the solid line cursor represents that cursor. It may or may not match the program cursor.



Move Wedge Cursor Popup Menu from the PA Wedge Menu Option

Rotate the Trim Knob control or use the touchscreen arrows to move the cursor. As the cursor moves, the *CURSOR* value displayed at the bottom of the information window changes. Note that the original cursor position (dashed line) remains marked as a reference point.

Press the Trim Knob control or touch the *MOVE WEDGE CURSOR* option to close the popup menu. The word "*CURSOR*" and its value are cleared and the PA Wedge value changes to reflect the new cursor (solid line) placement.

NOTE

The PA wedge pressure value will not be displayed or entered into Cardiac Calculations or Vital Signs until you exit the program.

Select *MAIN MENU* or *CARDIAC OUTPUT* to exit the PA Wedge program. The most recent PA wedge pressure value and the time it was obtained are displayed in the PA parameter window and entered into Cardiac Calculations and Vital Signs.

Auto Mode

The Auto mode defaults on when the PA Wedge menu option is selected. When the PA Insert/Wedge menu option is selected, the Manual mode defaults on. Refer to "Manual Mode" on page 12-29 for more information.

NOTE

If you have already selected the *PA INSERT/WEDGE* menu option and you later select the *PA WEDGE* menu option, the Manual mode will be the default for the PA Wedge menu option, not the Auto mode.

1. Select the *PA WEDGE* option from the PA menu. The Auto mode defaults on.

   Or, select the *PA INSERT/WEDGE* option from the PA menu, then select the *MODE: MANUAL* option to switch to the Auto mode.

   Watch for the *INFLATE BALLOON* prompt. You will hear a single beep when it is displayed.

2. Inflate the balloon. The PA program will look for inflation and begin processing an end-expiration wedge value. The prompt in the parameter window changes to *WEDGE PROCESSING*.

   NOTE

   At this point, select *PA CURSOR* from the PA Wedge or PA Insert/Wedge menu if you want to place a moveable cursor on the real-time wedged waveform. This in no way interferes with the wedge value the program computes. In the Review mode, you can then compare your cursor placement to the program's placement.

3. Deflate the balloon when you feel wedging is adequate (3-4 respiratory cycles, but no longer than 20 seconds). The prompt in the parameter window now reads *WEDGE COMPLETE*.

   A PA Wedge Review information window and menu are displayed on the screen. The information window contains 20 seconds of compressed waveform data (beginning with *INFLATE BALLOON* message) for ECG, respiration (if waveform is displayed), and PA. (Refer to the Review Wedge section in this chapter.)

   NOTE

   If you do not deflate the balloon, the *WEDGE COMPLETE* message and review window are automatically displayed after 20 seconds. If this occurs, be sure to deflate the balloon before proceeding.

   A program cursor (horizontal dashed line) is placed on the compressed PA waveform at end expiration and a wedge value relative to the cursor is displayed. The time of the measurement is also displayed. The scale displayed is automatically determined from the patient's PA data.

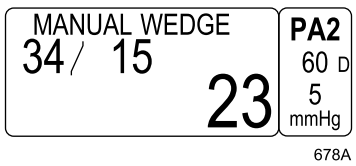
Manual Mode

Under certain patient conditions (valvular disease or respiratory variation in PA reading), the program is unable to detect the wedge. The waveform indicates wedging but the program will not progress beyond the Inflate Balloon prompt, or the program indicates *WEDGE PROCESSING* but the balloon has not been inflated. In these cases, the Manual mode should be used. Follow this procedure:

1. Select the *PA INSERT/WEDGE* option from the PA menu. The Manual mode defaults on.

   Or, select the *PA WEDGE* option from the PA menu, then select the *MODE: AUTO* option to switch to the Manual mode.

   The message *MANUAL WEDGE* appears in the PA parameter window.



***MANUAL WEDGE* Message**

2. Inflate the balloon. Watch the PA waveform for wedging. If you wish, you can place a cursor on the wedged waveform at this point and move it as desired.
3. Deflate the balloon when you feel wedging is adequate (3-4 respiratory cycles, but no more than 20 seconds).
4. The Manual mode does not automatically display the review data. You must select *REVIEW WEDGE*. The program continues to collect data until *REVIEW WEDGE* is selected. If you wait too long you will lose the wedge data. The last 20 seconds of data is displayed.
5. Select *MOVE WEDGE CURSOR* if you don't agree with the PA wedge pressure value. (Refer to the Move Cursor section in this chapter.)

Full Scales

The *FULL SCALE* option lets you to change the scale of the full BP from its default scale of 40 mmHg. Select this option to open a popup menu with the choices *300-L*, *200-L*, *160-L*, *100-L*, *60-L*, or *40-L* mmHg.

NOTE
This option is only found in the PA Insert/Wedge menu.

Speed

Use this menu option to open a popup menu to select a sweep speed for the displayed pressure waveform. You can change the waveform sweep speed of the second, full, and seventh pressure waveforms. Choices are 6.25, 12.5, 25 (default) and 50 millimeters per second.

Graph BP Invasive

This menu option opens a popup menu that allows you to select the available BP waveform for graphing. When this option is activated, BP waveforms are the only parameters that can be graphed. Waveforms are graphed on one scale using the full grid space.

You cannot change a BP selection while graphing. The graph will stop when the **Graph Go/Stop** button on the keypad or writer is pressed. If another type of graph is currently active, the graph BP invasive selection will be ignored. BP graphing goes to the manual graph window location. (Refer to the Graph BP Invasive section in Chapter 5, Monitor Setup, for more details.)

General Troubleshooting

Problem:	*Solution:*
Displayed pressure values are different than expected	Check tubing for bubbles. Remove excessive tubing. Check phlebostatic axis placement of transducer. Rezero pressure: 1. Close transducer stopcock to patient. 2. Open the venting stopcock to air. 3. Press **Zero All**. 4. Close the venting stopcock to air. 5. Open transducer stopcock to patient. Is patient on IABP? If so, check to see if monitor's IABP program is turned on. Look for an I in the ART parameter window. If necessary, turn IABP program on: 1. Select *ART* parameter label. 2. Select *IABP: OFF*. The menu option switches to *IABP: ON*.
Problem:	*Solution:*
Smart BP is on. Artifact is sensed without flush, draw, or zero	Turn Smart BP off, then on. If problem persists, you may need to disable Smart BP by turning it off for that pressure. Use the Alarm Pause feature prior to drawing blood to reduce unnecessary alarms if Smart BP is disabled.

Wedge Troubleshooting

Problem: *Unable to detect wedge*	*Solution:* Use the manual method for PA wedge measurement: 1. Select *MODE: AUTO* in the PA Wedge menu. Selection switches to *MANUAL*. 2. Perform wedge measurement in Manual mode following the procedure in the Manual Mode section in this chapter.
Problem: *Monitor displays "WEDGE PROCESSING" when balloon has not been inflated*	*Solution:* Select *NEW WEDGE* to begin wedge processing again. If wedge is again detected due to respiratory artifact on PA waveform, then use the manual method for PA wedge measurement: 1. Select *MODE: AUTO* in the PA Wedge menu. Selection switches to *MANUAL*. 2. Perform wedge measurement in Manual mode following the procedure in the Manual Mode section in this chapter.
Problem: *Displayed wedge measurement is different than expected*	*Solution:* 1. Repeat wedge measurement allowing a minimum of three respiratory cycles of data. 2. Verify end-expiration using the respiratory waveform on the display and observing patient's breathing pattern. 3. Adjust PA wedge cursor to end-expiratory wedge value.

13 NBP

For your notes

Introduction

A patient's vital signs may vary dramatically during the use of cardiovascular agents such as those that raise or lower blood pressure or those that increase or decrease heart rate.

Because treatment protocol based on the patient's blood pressure may rely on specific values and differing measurement methods, clinicians should note a possible variance from values obtained with this unit in planning patient care management. The Solar 8000M patient monitor values are based on the oscillometric method of noninvasive blood pressure measurement and correspond to comparisons with intra-aortic values within ANSI/AAMI Standards for accuracy.

WARNING
Non-invasive blood pressure monitoring is not recommended for patients experiencing seizures or tremors, or patients with hypotension, hypertension, arrhythmias, or extremely high or low heart rate. The software algorithm cannot accurately compute NBP on patients with these conditions.

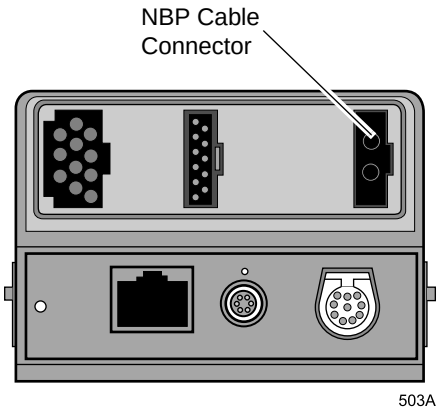
Automatic non-invasive blood pressure monitoring uses the oscillometric method of measurement. To understand how this method works, we will compare it to the auscultative method. With auscultation, the clinician listens to the blood flow and determines the systolic and diastolic pressures. The mean pressure can then be calculated with reference to these pressures as long as the arterial pressure curve is normal.

Since the monitor cannot hear the blood flow, it measures cuff pressure oscillation amplitudes. Oscillations are caused by blood pressure pulses against the cuff. The oscillation with the greatest amplitude is the mean pressure. This is the most accurate parameter measured by the oscillometric method. Once the mean pressure is determined, the systolic and diastolic pressures are calculated with reference to the mean.

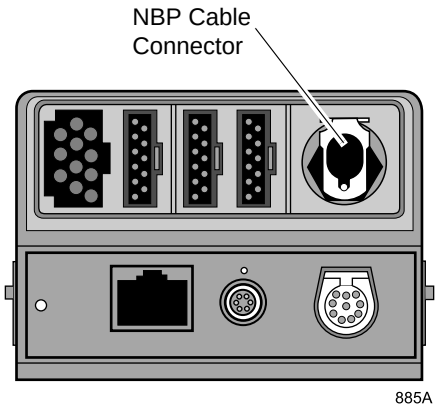
Simply stated, auscultation measures systolic and diastolic pressures and the mean pressure is calculated. The oscillometric method measures the mean pressure and calculates the systolic and diastolic pressures. Due to the difference in these methods, one cannot be used to check the accuracy of the other.

NOTE

Some Tram modules have a rectangular NBP connector and others have a rounded connector. Examples of the two types of connectors are shown below.



Tram 800SL Module



Tram 200SL Module

NOTE

The signal input is a high-insulation port and it is defibrillator proof (⏚).

The insulated input ensures patient safety and protects the device during defibrillation and electrosurgery.

Non-invasive blood pressure monitoring can be done with an appropriate Tram module or with a separate non-invasive blood pressure module. However, do not connect more than one NBP patient cable. This chapter gives guidelines for patient preparation and adjusting setup.

Checklist

1. The module is securely inserted in the Tram-rac housing.
2. A cuff appropriate for the limb size has been selected.
3. Cuff is properly placed on patient.
4. Patient cable is connected to module.

   NOTE
   Do not connect more than one NBP patient cable.

5. Tubes between the cuff and the monitor are not kinked or blocked.
6. Correct cuff size has been selected from the NBP menu.

   WARNING
   The cuff size selected in the NBP menu and the cuff size used must be correct to obtain reliable NBP data and to prevent overpressure in neonatal or pediatric use.

7. Start an NBP reading following Auto or Stat mode procedures as detailed in this chapter, or use the **NBP Go/Stop** button on the keypad or remote control.

Patient Preparation

Cuff selection and application are important. Inappropriate selection or improper application of the cuff will result in erroneous measurements.

WARNINGS

The system is designed for use with dual-hose cuffs and tubing. The use of single-hose cuffs with dual hose tubing can result in unreliable and inaccurate NBP data.

Use care when placing cuff on extremity used to monitor other patient parameters.

Do not place the cuff on a limb being used for A-V Fistulas, intravenous infusion or on any area where circulation is compromised or has the potential to be compromised.

Cuff selection:

1. Identify patient limb circumference.
2. Select appropriate cuff. The limb circumference is identified on each cuff.

Cuff placement:

1. Confirm that the cuff is fully deflated before positioning it on the patient.
2. Place cuff snugly around extremity being used.
3. Marking on cuff should match artery location.
4. Cuff should be one to two inches above the elbow if using the brachial artery.
5. The air pad should be exactly over the brachial artery. Tubing should be immediately to the right or left of the brachial artery to prevent kinking when elbow is bent.
6. Position the patient so that no external pressure is applied against the cuff while monitoring. External pressure may cause inaccurate blood pressure values.

Other considerations:

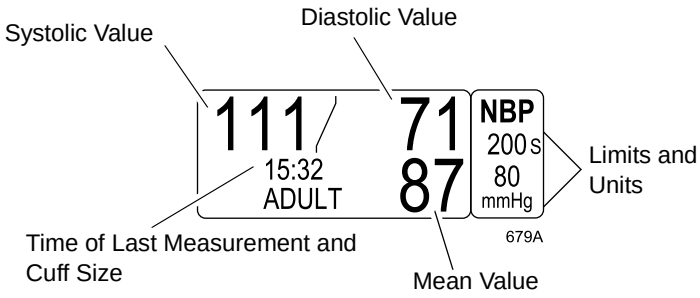
1. Perform NBP measurements on the patient's non-dominant arm.
2. Roll up sleeve before measurement. Only very thin fabrics will not impair the measurement.
3. Place the arm on a surface level with the patient's heart.
4. The palm of the hand should face up.

For further information on cuffs, please contact your sales/service representative.

NBP Monitoring Features

NBP Information

When monitoring NBP, numerics are displayed in the NBP parameter window on the right side of the display. However, there is no waveform displayed.



NBP Parameter Label and Windows

The current systolic, diastolic, and mean values are displayed. Limits and the units of measure may also be displayed. The limits displayed are labeled (*S*=systolic, *D*=diastolic, *M*=mean). The cuff size and time of the last measurement are also displayed. Time is displayed on a 24-hour clock. During a measurement, the cuff inflation pressure (updated every second) is shown in place of the mean value.

If auto mode is on, a countdown timer is displayed in the lower left corner.

The NBP values change to Xs if no NBP monitoring has taken place for two hours in Adult-ICU mode, 15 minutes in Operating Room mode, or 12 hours in Neonatal-ICU mode.

NOTE

When using a Tram module, the NBP parameter window is displayed even if a patient cable is not connected. However, if you are not monitoring NBP, you can use the parameters on/off feature in the monitor setup menu to turn NBP off and clear the NBP window from the screen.

Mean Arterial Pressure

The following conditions may cause the NBP parameter block to display the mean arterial pressure (MAP) value while the associated systolic and diastolic values appear as Xs.

- Very low systolic and diastolic amplitude fluctuations (e.g., patients in shock).
- Very small difference between the MAP and the systolic pressure or the MAP and the diastolic pressure.
- Loss of system integrity (e.g., loose connections or worn parts).

  Be sure to perform a visual inspection to ensure system integrity.

Systolic Search

NOTE

The cuff target pressure must be higher than the patient's systolic pressure to obtain an accurate systolic and diastolic reading.

If a systolic blood pressure cannot be found, the monitor will search for a systolic reading by re-inflating the cuff at a higher pressure. This systolic search may occur once per NBP determination. During a systolic search, the maximum cuff inflation pressure will not exceed the normal pressure range of the cuff.

NBP Go/Stop Button

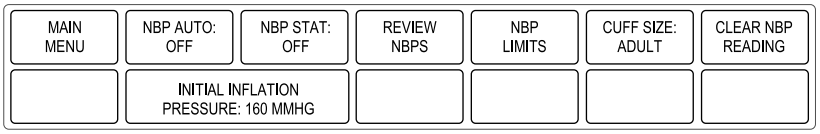
The **NBP Go/Stop** button on the keypad or remote control is a quick way to take one measurement without going into the NBP menu. It can also be used to stop a measurement already in progress.

Display On/Off Button

If you turn the display off with the **Display On/Off** button on the keypad or remote control, NBP is also turned off. This applies to both auto NBP (if running) and manual NBP. Turning the display on again enables manual NBP. It does not automatically restart auto NBP.

Getting to the NBP Menu

To display the NBP menu, select the NBP parameter label. The NBP menu is then displayed at the bottom of the screen.



NBP Menu

- *NBP AUTO* — Starts/stops the automatic mode; selects a time interval.
- *NBP STAT* — Starts five minutes of continuous, sequential NBP measurements (not available in Neonatal-ICU mode).
- *REVIEW NBPS* — Reviews previous NBP measurements in vital signs.
- *NBP LIMITS* — Displays an information window and a new menu to adjust systolic, diastolic, and mean limits.
- *CUFF SIZE* — Used to select the type of cuff being used (adult, pediatric, or neonatal).
- *CLEAR NBP READING* — Removes the values from the NBP parameter window.
- *INITIAL INFLATION PRESSURE* — Determines the target inflation pressure for the first measurement.

Detailed information about each option is found in this chapter.

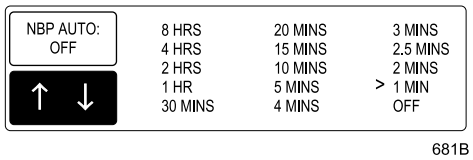
NBP Menu Options

NBP Auto

WARNING
Periodically check patient limb circulation distal to the cuff. Check frequently when using auto NBP in 1 and 2 minute intervals. The one and two minute intervals are not recommended for extended periods of time.

This option allows you to program the monitor to automatically take NBP measurements at specific time intervals.

Select *NBP AUTO* from the NBP menu. A popup menu opens, showing all choices.



NBP Auto Popup Menu

Use the Trim Knob control or touchscreen to select the desired time interval.

NOTE
The NBP auto program is a timed cycle. If, when first turned on, it is set to run at 5-minute intervals, the cuff inflates immediately and then every 5 minutes thereafter. If you change the timing interval (e.g., to 15 minutes) without turning the auto mode off, the timing cycle does not start over. The next cuff inflation will occur 15 minutes after the last inflation and every 15 minutes thereafter. Turning auto mode off, then on again restarts the timing cycle with an immediate cuff inflation.

A count-down timer is displayed in the NBP parameter window when the time interval set or the time interval remaining is 60 minutes or less. The last minute counts down in seconds.

NOTE
Operating Room mode — If an auto mode time is set in monitor defaults, pressing the **NBP Go/Stop** button starts the auto mode feature.

NBP Stat

NOTE

The NBP Stat feature is not available when the monitor is set for the Neonatal-ICU mode.

NBP Stat enables 5 minutes of continuous, sequential, automatic NBP measurements.

Select the *NBP STAT* option from the NBP menu. A popup menu opens, displaying the options *ON*, *OFF*, and *HELP*.

To enable NBP Stat, select *ON*. The first cuff inflation occurs within seconds.

To discontinue the NBP stat process before the 5 minutes are up, select *OFF* from the popup menu, or simply press the **NBP Go/Stop** button on the keypad.

Early Systolic Measurement

Early systolic measurement is a feature of the NBP Stat mode. As soon as you enter NBP Stat mode, cuff inflation begins, a measurement is taken, and the systolic, diastolic, and mean values are displayed. Thereafter, the systolic value will be displayed shortly after the measurement starts. When the measurement is complete, the monitor will beep and the final measurement values will be displayed.

Review NBPs

The monitor can store up to 96 NBP readings, which can be reviewed in Vital Signs. This is equivalent to running Auto mode at 15-minute intervals for 24 hours. Readings older than 24 hours are cleared from Vital Signs.

1. Select the *REVIEW NBPS* option from the NBP menu. The Vital Signs information window is displayed, with the data sorted so NBP readings appear first in the list.
2. Select the desired menu options. Refer to the Vital Signs section in Chapter 10, Patient Data, for more details.

   NOTE

   The menu options *TIME INTERVAL* and *SPECIFIC TIME* do not work with episodic events such as NBP.

3. Select *PREVIOUS MENU* to return to the NBP menu.

NBP Limits

Select *NBP LIMITS* to open an information window and a new menu, which allow you to adjust the following:

- Systolic (*SYS*) high and low limits
- Diastolic (*DIA*) high and low limits
- Mean high and low limits

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

Cuff Size

This option sets the monitor for the appropriate cuff inflation pressure. Selecting *CUFF SIZE* from the NBP menu opens a popup menu with three choices — *ADULT*, *PEDIATRIC*, and *NEONATAL*.

NOTE

The initial cuff size is automatically set when you enter the patient's age in the Admit menu.

If you need to select a different size, make a selection from the popup menu.

Clear NBP Reading

If you want to remove the values displayed in the NBP parameter window, select this option. The values are replaced with Xs. This action also removes those values from vital signs history.

Initial Inflation Pressure

This option allows you to set the target inflation pressure for the first NBP measurement.

1. Select the *INITIAL INFLATION PRESSURE* pressure from the NBP menu.
2. A popup menu opens, in which you can scroll through a selection of inflation pressures. The choices available depend on the cuff size selected. For adult and pediatric cuff sizes, the choices are 100 mmHg to 250 mmHg. For the neonatal cuff size, the choices are 100 mmHg to 140 mmHg.

   Inflation pressures can be adjusted in increments of 5 mmHg within the inflation limits of the cuff size selected.
3. Select the desired initial inflation pressure and close the popup menu.

Cuff inflation thereafter is automatically determined by multiple factors, including the cuff size selected and the previous NBP reading.

Initial inflation pressure can also be set in monitor defaults.

NOTE

This option only appears when the Tram module is running software version 10B or later.

Troubleshooting

NBP Status Messages

A status message is displayed in the NBP values window if a measurement cannot be completed. Following is an alphabetical list of the status messages, along with the monitor's response and corrective actions to take.

Status Message	Monitor Response	Solution
CUFF INFLATION OVER 5 MINS	System status alarm. Auto mode will shut off.	Check cuff, if no air is in cuff, try another measurement. If problem persists, contact service. If air is in cuff, remove cuff and contact service.
DEFLATION FAIL, REMOVE CUFF	System status alarm. Auto mode will shut off.	Remove cuff and contact service.
NBP HARDWARE MALFUNCTION	System status alarm. Auto mode will shut off.	Contact service.
NO DETERMINATION	System status alarm.	Check patient and cuff placement; try another measurement. If problem persists, contact service.
OVER PRESSURE	System status alarm. Auto mode will shut off.	Remove cuff and contact service.
PUMP TIMEOUT (inflation failure/pressure leak)	System status alarm.	Check connections between cuff and module; try another measurement. If problem persists, contact service.
TOTAL TIMEOUT (Measurement > 3 minutes)	System status alarm.	Possible excessive patient movement or arrhythmia condition. Check patient; try another measurement. For neonatal mode, the status message will appear after 90 seconds.

Any two consecutive NBP status messages will shut off auto mode if it is running.

A message will clear when the next measurement is initiated, or a message can be cleared manually with the clear NBP reading option in the NBP menu.

An NBP status message is also included in the graph header in an abbreviated form, when applicable.

Problem: Erroneous NBP measurement

Solutions:

1. Check for proper cuff size:
   a. Too small a cuff can give an erroneously high value.
   b. Too large a cuff can give an erroneously low value.
2. Check for residual air left in the cuff from a previous measurement.
3. Make sure that the cuff is not too tight or too loose.
4. Make sure that the cuff and the heart are at the same level. Otherwise, hydrostatic pressure will offset the NBP value.
5. Minimize patient movement during measurement.
6. Watch for pulsus paradoxis.
7. Check for leak in cuff or tubing.
8. Patient may have a weak pulse.
9. Calibration may be necessary.

14 SPO2

For your notes

Introduction

NOTE

SpO2 and SPO2 are used interchangeably in this manual.

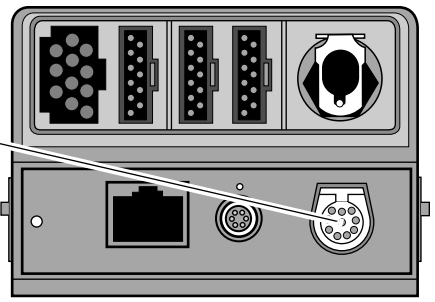
SpO2 monitoring is a non-invasive technique used to measure the amount of oxygenated hemoglobin and pulse rate. This is done by measuring the absorption of selected wavelengths of light. The light generated in the probe passes through the tissue and is converted into an electrical signal by the photodetector in the probe. The module processes the electrical signal and displays a waveform and digital values for SpO2 and pulse rate.

SpO2 (pulse oximetry) monitoring is done with a Tram module that has the SpO2 feature and/or a single-parameter SpO2 module. There are two types of single-parameter SpO2 modules, the Solar SpO2 module and the Solar SpO2 module with Masimo SET (referred to as the Masimo SET module). It is possible to monitor two SPO2 sites when using a Tram module and a single-parameter module. This chapter provides guidelines for successful SPO2 monitoring.

545A

Tram 451N Module

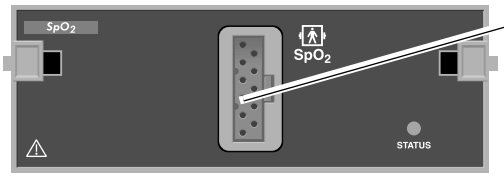
SpO2 Cable Connector



885A

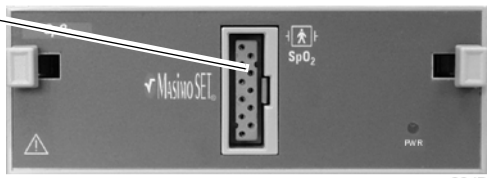
Tram 200SL Module

SpO2 Cable Connector



798A

Solar SpO2 Module



894B

Solar SpO2 Module with Masimo SET

NOTE

The signal input is a high-insulation port and it is defibrillator-proof ().

The insulated input ensures patient safety and protects the device during defibrillation and electrosurgery.

Module and Probe Compatibility:

NOTE

Nellcor, GE Medical Systems *Information Technologies*, and Masimo pulse oximetry is calibrated to display functional saturation. Ohmeda pulse oximetry is calibrated to display fractional saturation.

- Tram x51 modules are compatible with GE Medical Systems *Information Technologies* probes.
- Tram x51M modules are compatible with Masimo LNOP probes.
- Tram x51N modules are compatible with Nellcor Oxismart XL probes. Other Nellcor cables cannot be plugged into this connector.
- Tram x00 modules with SpO2 are compatible with Ohmeda probes.
- Tram x50 modules are compatible with Nellcor and GE Medical Systems *Information Technologies* probes.
- The Solar SpO2 module is compatible with Nellcor and GE Medical Systems *Information Technologies* probes.
- The Masimo SET module is compatible with Masimo LNOP probes.

NOTE

The SpO2 cable should plug into the module's SpO2 connector easily and securely. Do not use excessive force to connect the cable. If the SpO2 cable does not easily fit into the SpO2 connector on the module, it is likely that you do not have the appropriate cable for that module.

Safety

WARNINGS

APNEA — A pulse oximeter should NOT be used as an apnea monitor.

EARLY WARNING — A pulse oximeter should be considered an early warning device. As a trend toward patient deoxygenation is indicated, blood samples should be analyzed by a laboratory co-oximeter to completely understand the patient's condition.

EXPLOSION HAZARD — Do not use the SpO2 modules in the presence of flammable anesthetics or other flammable substance in combination with air, oxygen-enriched environments, or nitrous oxide.

INTERFERING SUBSTANCES — Carboxyhemoglobin may erroneously increase SpO2 readings. The level of increase is approximately equal to the amount of carboxyhemoglobin present. Dyes, or any substance containing dyes, that change usual arterial pigmentation may cause erroneous readings.

MRI INTERFERENCE — Do not use SpO2 modules or probes during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns. The module may affect the MRI image, and the MRI unit may affect the accuracy of the oximetry measurements.

Measurements

If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs by alternate means, then check the SpO2 module for proper functioning.

Inaccurate measurements may be caused by:

- Incorrect probe application or use.
- Significant levels of dysfunctional hemoglobins (e.g., carboxyhemoglobin or methemoglobin).
- Intravascular dyes such as indocyanine green or methylene blue.
- Exposure to excessive illumination, such as surgical lamps, bilirubin lamps, fluorescent lights, infrared heating lamps, or direct sunlight.

  NOTE

  Exposure to excessive illumination can be corrected by covering the probe with a dark or opaque material.

- Excessive patient movement.
- Venous pulsations.
- Placement of a probe on an extremity with a blood pressure cuff, arterial catheter, or intravascular line.
- Excessive environmental motion or electromagnetic interference may prevent tracking of pulse. Measurements may seem inappropriate or the monitor may not seem to operate correctly.

The SpO2 modules can be used during defibrillation, but the readings may be inaccurate for a short time.

Neonates and Infants

NOTE

This section is not applicable to monitoring SpO2 with the Masimo SET module and probes, or with Tram x51M modules.

WARNING

The display of inaccurate pulse oximetry (SPO2) values has been linked to the presence of poor signal strength or artifact due to patient motion during signal analysis. This condition is most likely to be encountered when the monitor is used on neonates or infants. These same conditions in adults do not impact the SPO2 values to the same extent.

When using pulse oximetry on neonates and infants, always observe the following precautions.

PRECAUTIONS

We recommend the application of the following criteria when using the pulse oximetry function on neonates and infants:

1. The peripheral pulse rate (PPR) as determined by the SPO2 function must be within 10% of the heart rate, and
2. the SPO2 signal strength indicator must have two or three asterisks displayed.

Procedures or devices previously applied in your facility for SPO2 monitoring should be used in the event that the SPO2 value from the monitor cannot be validated by the above criteria.

Checklist

1. The acquisition module is securely inserted in the Tram-rac housing.
2. The SPO2 probe is correctly positioned on the patient. (Follow the instructions provided with the probe.)
3. The patient cable is connected to the module.
4. The SPO2 setup is adjusted, if necessary. Follow the procedures in this chapter.

Patient Preparation

Follow these steps to prepare the patient for SPO2 monitoring.

1. Choose the probe that is best suited to your patient — ear, finger, disposable, reusable, etc.

   NOTE
   If you are using a Nellcor compatible module, Nellcor's RS-10 reflective probe is not recommended for use. Contact Nellcor for other probe options.

2. Clean the surface of the probe before and after each use.
3. Following the instructions provided with the probe, correctly position and attach the probe to your patient.

Be aware of the following general safety precautions when using SPO2 probes:

WARNINGS

DATA VALIDITY — Do not expose probe detector to strong ambient light while monitoring a patient. A poor signal may result.

DATA VALIDITY — Do not allow tape to block the probe light detector.

DATA VALIDITY — Check that the SPO2 waveform is physiological in shape. (Not applicable when monitoring SpO2 with the Masimo SET module and probes, or Tram x51M modules.)

PATIENT SAFETY — Prolonged monitoring may require changing the probe site periodically. Move the probe if there is any sign of skin irritation or impaired circulation. Change the probe site at least every four hours to prevent ischemic skin necrosis. Be particularly careful when monitoring neonates. If required, reduce the application periods to half the times recommended above.

PATIENT SAFETY — If a probe is damaged in any way, discontinue use immediately.

Be sure to read all literature accompanying probes for specific safety information.

Signal and Data Validity

It is extremely important to determine that the probe is attached to the patient correctly and that the data is verifiable. To make this determination, three indications from the monitor are of assistance — the signal strength indicator, the quality of the SPO2 waveform, and the stability of the SPO2 values. It is critical to observe all three indications simultaneously when ascertaining signal and data validity.

Signal Strength Indicator

NOTE

When monitoring SpO2 using Nellcor Oxismart technology (Tram x51N modules) and the Sat-Seconds feature is active, the signal strength asterisks are not displayed. Signal strength may be determined by the amplitude of the SpO2 waveform.

The signal strength indicator is displayed in the SPO2 values window. It consists of 0, 1, 2, or 3 (strongest) asterisks, depending on the strength of the signal. Proper environmental conditions and probe attachment will help ensure a strong signal.

Quality of SPO2 Waveform

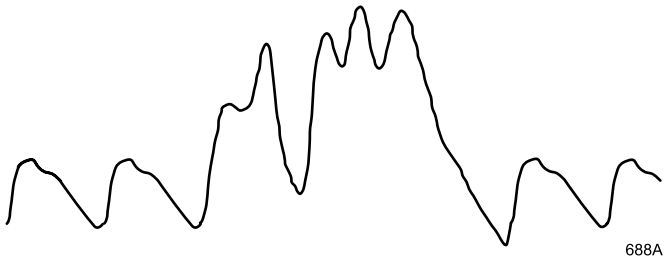
NOTE

This section is not applicable to monitoring SpO2 with the Masimo SET module and probes, or with Tram x51M modules.

Under normal conditions, the SPO2 waveform corresponds to (but is not proportional to) the arterial pressure waveform. The typical SPO2 waveform can help the user find a probe location with the fewest noise spikes. The figure below represents an SPO2 waveform of good quality.

Good Quality SPO2 Waveform

If noise (artifact) is seen on the waveform because of poor probe placement, the photodetector may not be flush with the tissue. Check that the probe is secured and the tissue sample is not too thick. Pulse rate is determined from the SPO2 waveform, which can be disrupted by a cough or other hemodynamic pressure disturbances. Motion at the probe site is indicated by noise spikes in the normal waveform. (See the figure below.) It has been noted that letting the patient view the SPO2 waveform enables the patient to assist in reducing motion artifact.



SPO2 Waveform with Artifact

Stability of SPO2 Values

The stability of the displayed SPO2 values can also be used as an indication of signal validity. Although stability is a relative term, with some practice one can get a good feeling for changes that are artifactual or physiological and the speed of each.

To aid you in successful SPO2 monitoring, messages are provided in the SPO2 values window. Refer to the Troubleshooting section in this chapter.

WARNING
In the monitoring of patients the coincidence of adverse conditions may lead to a disturbed signal going unnoticed. In this situation artifacts are capable of simulating a plausible parameter reading, so that the monitor fails to sound an alarm. In order to ensure reliable patient monitoring, the proper application of the probe and the signal quality must be checked at regular intervals.

Masimo SET Modules and Probes

The Masimo SET module and the Tram x51M modules are used to non-invasively measure the amount of oxygenated hemoglobin and pulse rate. The absorption of selected wavelengths of light is measured with Masimo LNOP probes. Although these modules process the SpO2 measurements differently, the function and appearance of SpO2 on your monitor is essentially the same as SpO2 monitoring with any other SpO2 module.

No Implied License

Possession or purchase of this device does not convey any express or implied license to use the device with unauthorized replacement parts which would, alone, or in combination with this device, fall within the scope of one or more of the patents relating to this device.

Probes

Before use, carefully read the Masimo LNOP probe directions for use.

Use only Masimo oximetry probes with the Masimo SET module and the Tram x51M modules. Other probes (sensors) may cause improper performance.

CAUTION
Tissue damage can be caused by incorrect application or use of an LNOP probe, for example by wrapping the probe too tightly. Inspect the probe site as directed in the probe's directions for use to ensure skin integrity and correct positioning and adhesion of the probe.

Do not use damaged LNOP probes. Do not use an LNOP probe with exposed optical components. Do not immerse the probe in water, solvents, or cleaning solutions. The probes are not waterproof. Do not sterilize by irradiation, steam, or ethylene oxide. See the cleaning instructions in the directions for use for reusable Masimo LNOP probes.

Masimo SET Module PWR Indicator Light

On the front panel of the Masimo SET module, there is an indicator light labeled **PWR**.

Masimo SET Module

The **PWR** indicator light flashes when the module is first inserted in a Tram-rac housing with power applied to it. It illuminates steady green during normal module operation. If there is a problem during module operation, it will again flash as the module turns off. The **PWR** indicator light is not illuminated when the module is off.

NOTE

When used with a powered Tram-rac housing, the patient isolated circuitry voltage is enabled by the host monitor as indicated by the **PWR** indicator light.

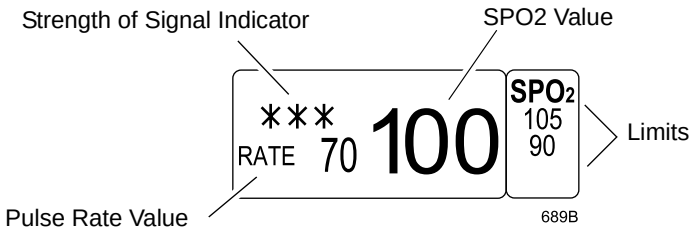
SPO2 Monitoring Features

SPO2 Information

A waveform labeled SPO2 is displayed on the monitor when the patient cable is connected to the module. Numerics are also displayed in the SPO2 parameter windows on the right side of the screen.

NOTE

Visual indication of the patient's pulse is not proportional to the pulse amplitude.

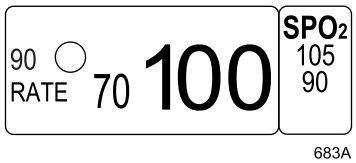


SPO2 Parameter Window

The current SPO2 value and the derived pulse rate (*RATE*) are displayed. The asterisks indicate the signal strength (three asterisks indicate the strongest signal).

NOTE

When monitoring SpO2 using Nellcor Oxismart technology (Tram x51N modules) and the Sat-Seconds feature is active, the signal strength asterisks are not displayed. Signal strength may be determined by the amplitude of the SpO2 waveform.



SPO2 Parameter Window with Sat-Seconds active

GE and Ohmeda SPO2 measurements are averaged over a 6-second period of time in the Adult-ICU mode, and a 12-second period of time in the Neonatal-ICU mode. The longer averaging time for the Neonatal-ICU mode is to help decrease false alarms related to patient motion artifact.

NOTE

The Tram x51M modules have adjustable averaging times.

The Tram x51N modules use Nellcor's standard averaging for all monitoring modes.

The monitor display is updated every two seconds.

The SPO2 monitoring features are found in the SPO2 menu. These features include waveform size, alarm limit adjustment, display of rate and rate volume.

Two SPO2 Sites

With the Solar SPO2 module or the Masimo SET module and a Tram module, it is possible to monitor two SPO2 sites at one time. (You cannot, however, monitor two SpO2 sites using two single-parameter SPO2 modules or two Tram modules.) When monitoring two sites, the software identifies the SPO2 data from the module by displaying *MODULE* at the top of the values window, and the associated waveform is labeled *SPO2M*.

NOTE

When monitoring only one SPO2 site, the identifiers described above are not present.

SPO2 and NBP Simultaneously

When monitoring SpO2 and NBP simultaneously, a feature called SpO2-NBP interlock is available. This is a feature that prevents SpO2 alarms from sounding during an NBP measurement. However, if SPO2 is alarming when an NBP measurement begins, SPO2 will continue to alarm during the NBP measurement.

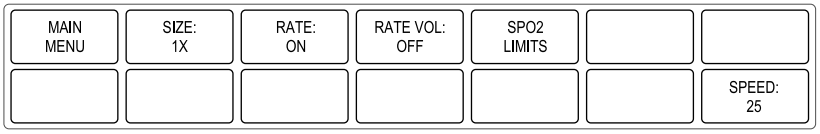
The SPO2-NBP interlock feature defaults *ON*. It can be turned on and off using the Setup Default Display window in the Monitor Setup menu.

NOTE

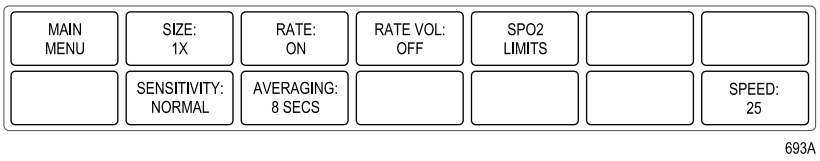
If using the SpO2 Sat-Seconds feature available with Tram 451N and 851N modules, the count value will continue to increment if the patient is outside the SpO2 limits when an NBP measurement begins. If the saturation is within limits when the NBP measurement begins, the count value is locked and will not increase or decrease during the NBP measurement.

Getting to the SPO2 Menu

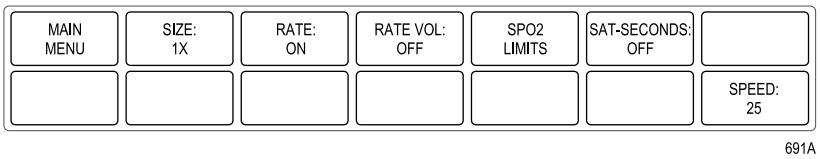
To display the SPO2 menu, select the SPO2 parameter label. The SPO2 menu is then displayed at the bottom of the screen. The menu options that appear are dependent on the type of module and probe used.



SPO2 Menu — GE, Ohmeda, and Nellcor (non-Oxismart XL) Probes



SPO2 Menu — Masimo Probes



SPO2 Menu — Nellcor Oxismart XL Probes

- *SIZE* — Adjusts the size of the displayed SPO2 waveform.
- *RATE* — Turns the displayed rate value on and off.
- *RATE VOL* — Turns the rate volume on and off; adjusts the volume when on.
- *SPO2 LIMITS* — Displays a new menu and an information window to adjust SPO2 percent and rate (beats per minute) alarm limits.
- *SPEED* — Changes the sweep speed for the displayed SPO2 waveform.
- *SENSITIVITY* — Adjusts the Masimo probe sensitivity.
- *AVERAGING* — Adjusts the SPO2 averaging time, when using Masimo-compatible modules and probes.
- *SAT-SECONDS* — Adjusts the Sat-Seconds limit, when using Nellcor Oxismart XL-compatible modules and probes.

Detailed information on each option is found in this chapter.

SPO2 Menu Options

Size

The Size option allows you to change the size of the displayed SPO2 waveform. When you select *SIZE* from the SPO2 menu, a popup menu opens, displaying the following choices: *8X, 4X, 2X, 1X*. The default size is *1X*.

Use the Trim Knob control or touchscreen to select the desired size.

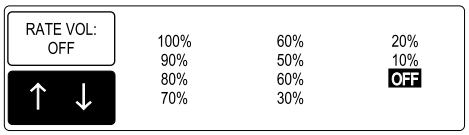
Rate

A pulse rate is derived from the SPO2 signal and is displayed in the parameter window. To turn this displayed rate off and on, simply select the *RATE* option from the SPO2 menu. This is a direct action menu option.

Rate Volume

The rate volume option turns on a tone that sounds each time an SPO2 pulse is detected. This is a variable pitch tone, which changes as the patient's saturation level changes; as the saturation level decreases, the pitch of the tone also decreases. The volume of this tone can be adjusted.

Select the *RATE VOL* option from the SPO2 menu. A popup menu opens.



Rate Vol Popup Menu

Rotate the Trim Knob control or use the touchscreen arrows to select an option. You will hear the tone volume when an option is highlighted. When you have selected the desired volume level, press the Trim Knob control or touch the *RATE VOL* option to close the popup menu.

NOTE

Turning the rate volume on automatically turns the QRS volume off. If monitoring two SPO2 sites, rate volume can only be turned on for one site at a time.

When in the Operating Room mode, the 10% and 20% volume tones are slightly quieter than the 10% and 20% volume tones in the Adult-ICU or Neonatal-ICU modes.

SPO2 Limits

Select *SPO2 LIMITS* to open an information window and a new menu, which allow you to adjust the following:

- SPO2 high and low limits
- Rate high and low limits

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

Speed

Use this menu option to open a popup menu to select a sweep speed for the displayed SPO2 waveform. Choices are 6.25, 12.5, 25 (default), and 50 millimeters per second.

Sensitivity

NOTE

This menu option only appears when using a Tram x51M module and a Masimo probe.

The Sensitivity menu option allows you to select *NORMAL* or *MAXIMUM* sensitivity. The default setting is *NORMAL*.

- Use the Normal sensitivity setting for normal patient monitoring purposes.
- Use the Maximum sensitivity setting for improved low perfusion performance and for faster tracking of rapid SpO2 saturation changes.

CAUTION

Using the Maximum sensitivity setting delays the Probe Off Patient detection alarm.

Averaging

NOTE

This menu option only appears when using a Tram x51M module and a Masimo probe.

The Averaging menu option provides the following selections for SpO2 averaging time: 2, 4, 8, 10, 12, 14, or 16 seconds. The default averaging time for all monitoring modes is 8 seconds. The selected averaging time is displayed on the Averaging menu option.

NOTE

For the 2- and 4-second averaging settings, the actual averaging times may range from 2 to 4 seconds and 4 to 6 seconds, respectively.

Sat-Seconds

NOTE

This menu option only appears when using a Tram x51N module and a Nellcor Oxismart XL probe.

The Sat-Seconds menu option allows you to adjust the Sat-Seconds threshold. Refer to “Sat-Seconds Alarm Management” in this chapter for more information.

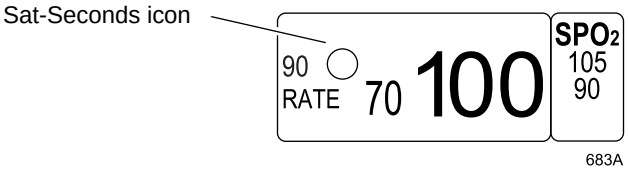
Sat-Seconds Alarm Management

The Sat-Seconds (or saturation seconds) feature available with the Tram x51N modules uses Nellcor Oximart XL technology to decrease the likelihood of false SpO2 alarms caused by motion artifact.

This feature defaults OFF. It can, however, be set on or off in Monitor Defaults. If the SpO2 parameter window is displayed as a full-size parameter window and the Sat-Seconds feature is turned on, the Sat-Seconds icon will appear in the window.

NOTE

The Sat-Seconds feature is not available in reduced size parameter windows. Additionally, if the Sat-Seconds feature is turned on and the parameter window is changed from full size to reduced size, the Sat-Seconds feature will be automatically set to *OFF*. When the parameter window is restored to full size, the Sat-Seconds feature is not automatically activated.



SPO2 Parameter Window with Sat-Seconds Icon

NOTE

When the Sat-Seconds feature is turned on, the signal strength asterisks are not displayed on the monitor. Signal strength may be determined by the amplitude of the SpO2 waveform.

With traditional pulse oximetry alarm management, upper and lower alarm limits are set. During monitoring, as soon as a limit is violated, an alarm is generated.

With Sat-Seconds alarm management, upper and lower alarm limits are set in the same way as traditional alarm management. A Sat-Seconds limit is also set. This allows monitoring of SpO2 saturation outside the set limits for a period of time (count value) before an alarm sounds.

NOTE

The Sat-Seconds feature applies to SpO2 saturation only. It does not apply to peripheral pulse rate.

The *SAT-SECONDS* option in the SPO2 menu allows you to set the Sat-seconds limit. The Sat-Seconds limit controls the amount of time that SpO2 saturation may be outside the set limits before an alarm sounds.

NOTE

If the Sat-Seconds limit is set to *OFF*, any SpO2 limit violation will cause an alarm.

The method of calculation is as follows: The number of percentage points that the SpO2 saturation falls outside the alarm limit is multiplied by the number of seconds that it remains outside the limit. This can be stated as the equation "points x seconds = Sat-Seconds," where points equals SpO2 percentage points at or outside the limit, and seconds equals the number of seconds SpO2 remains at that point outside the limit.

NOTE

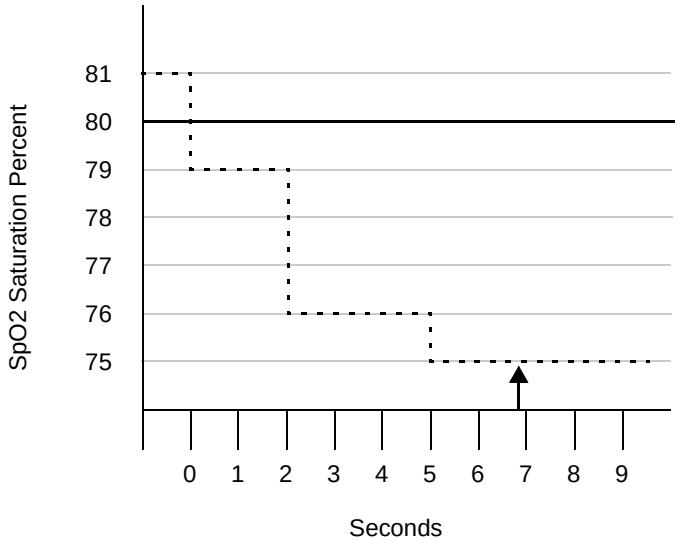
GE Medical Systems *Information Technologies* monitors sound an alarm when the parameter value is equal to the limit value. Therefore, an SpO2 saturation equal to the alarm limit is considered to be outside the limit. In other words, if a low limit were set to 80%, an SpO2 saturation of 80% would be a limit violation because 80% is the set low limit. An SpO2 saturation of 81% would be the nearest in-limit value.

For example, the figure below demonstrates the alarm response time with a Sat-Seconds limit set at 30 and a lower SpO2 limit of 80%.

In this example, the SpO2 level drops to 79% (2 points) and remains there for 2 seconds. Then it drops to 76% (5 points) for 3 seconds, and then to 75% (6 points) for 2 seconds. The resulting Sat-Seconds are:

SpO2 Saturation	Seconds	Sat-Seconds
2 x	2 =	4
5 x	3 =	15
6 x	2 =	12
Total Sat-Seconds		**31**

After approximately 7 seconds, the Sat-Seconds alarm would sound because 30 Sat-Seconds would have been exceeded (arrow in chart below).



Sat-Seconds Alarm Response Example

Saturation levels may fluctuate above and below an alarm limit, re-entering the acceptable range (non-alarm range) several times. During such fluctuation, the monitor integrates the number of SpO2 saturation points, both positive and negative, until either the Sat-seconds limit is reached or the saturation level returns to within the normal range and remains there.

Sat-Seconds Display

When an SpO2 saturation value exceeds an alarm limit, a pie chart (circular graph) in the SpO2 parameter window begins to “fill” in a clockwise direction. As seconds pass and the value is compared against the alarm limits and the Sat-Seconds setting, the chart fills proportionately. When the pie chart is completely filled, indicating that the Sat-Seconds limit has been reached, an alarm sounds. When the SpO2 value is within the set limits, the Sat-Seconds pie chart “empties” in a counterclockwise direction.

Sat-Seconds “Safety Net”

The Sat-Seconds feature has a “safety net,” designed for patients whose SpO2 saturation is frequently outside the limits but does not remain outside the limits long enough for the Sat-Seconds limit to be reached. When three or more limit violations occur within 60 seconds, an alarm sounds even if the Sat-Seconds limit has not been reached.

Probe Off Patient Condition

When using a reusable finger probe or a Masimo adhesive probe, there is a system alarm to alert you when the probe is off the patient. This “Probe Off Patient” condition defaults to a system warning alarm. You can change it to a system advisory alarm in Monitor Defaults. Refer to the Setup Default Display section in Chapter 5, Monitor Setup. It is identified as *SPO2 PROBE OFF* in the Setup Display information window.

Pulse Search Condition

When using a reusable finger probe or a Masimo adhesive probe, there is a system alarm to alert you when detection of a repeatable pulse has ceased. This “Pulse Search” condition defaults to a system advisory alarm. You can change it to a system warning alarm in Monitor Defaults. Refer to the Setup Default Display section in Chapter 5, Monitor Setup. It is identified as *SPO2 PULSE SEARCH* in the Setup Display information window.

Troubleshooting

SPO2 Messages

Below is a list of system status alarm messages that may be displayed in the SPO2 parameter window during monitoring. The messages displayed depend on the software installed in your monitoring system and the type of module you are using. SPO2 messages appear in abbreviated form in graph headers.

If you are unable to resume SPO2 monitoring, call GE Medical Systems *Information Technologies* service at 1-800-558-7044 (U.S. only). Outside the United States, please contact your sales/service office.

ARTIFACT DETECTED

No SPO2 data is displayed due to signal interference or too much ambient light. Check the patient and the probe.

LOW QUALITY or *LOW QUALITY SIGNAL*

SPO2 data continues to be displayed, but the quality of the signal is questionable. Check the patient and the probe.

PROBE IS OFF THE PATIENT

The disposable or reusable probe is off the patient. No SPO2 data is displayed. Check the probe.

NOTE

The factory default for this alarm is system warning. You can set it to be a system advisory alarm in your Monitor Defaults.

PROBE OR MODULE MALFUNCTION

No SpO2 data is displayed due to an unrecognized or defective probe.

If using a Tram module, try the following solutions in order:

1. Change the probe.
2. Change the cable.
3. Change the module.
4. Call service.

If using a single-parameter module, try the following solutions in order:

1. Remove and reinsert the module.
2. Remove the module, change the probe, then reinsert the module.
3. Remove the module, change the cable, then reinsert the module.
4. Change the module.
5. Call service.

POOR SIGNAL QUALITY DETECTED

The SPO2 signal is too low. No SPO2 data is displayed. This can be due to a low patient pulse, patient motion, or some other interference. Check the patient and the probe.

PULSE SEARCH

One of the following conditions is indicated:

- Defective or damaged probe,
- Defective or damaged cable,
- Probe is off the patient, or
- Detection of a repeatable pulse has ceased.

Check the probe and cable; reposition or replace as needed.

Clinical Questions

The following clinical questions are frequently asked about SPO2 monitoring. These may help in troubleshooting when monitoring SPO2.

Why does the monitor (pulse oximeter) sometimes read differently than a blood gas analyzer?

Blood gas analyzers calculate the O2 saturation based on normal values for pH, PaCO2, Hb, temperature, etc. (i.e., a normal oxyhemoglobin dissociation curve). Depending on the patient's physiologic and metabolic status, his curve and all his values may be shifted away from "normal." Thus the oximeter, which measures O2 saturation, may not agree with the ABG.

A CO-oximeter is an analyzer which also measures O2 saturation. The saturation of hemoglobin may be much closer to a pulse oximeter in these cases.

How does a pulse oximeter "read" the various types of hemoglobins?

All pulse oximeters utilize two-wavelength absorption. This is because reduced hemoglobin (RHb) and oxyhemoglobin (HbO2) absorb these two wavelengths differently. The hemoglobin saturation is then figured from the measured amounts of the hemoglobins: (SpO2–HbO2)/(HbO2 + RHb). Carboxyhemoglobin (COHb) absorbs similarly to HbO2 and thus can raise the SpO2. Normal levels of COHb are 1-2%. Methemoglobin (MetHb) usually represents less than 1% total Hgb, but in cases such as some IV dyes, antibiotics, etc. this level may go up sharply. MetHb absorbs similarly to RHb, and thus could lower the SpO2 reading. Fetal Hb absorbs like adult Hb, thus the oximeter has the same accuracy with neonates and adults.

What effect can ambient light have on pulse oximetry monitoring?

Ambient light can have numerous effects. In the newborn, ICU bili lights can affect the readings of the oximeters. Outside light striking the probe detector can give poor waveform and inaccurate readings. Sunlight or bright indoor lights can have the same effect in other areas of the hospital using oximetry. Error messages such as *PROBE OFF PATIENT* or *CHECK PROBE*, etc. are possible. Shielding the probe with opaque tape, the posey wrap, or other material can thus increase oximetry accuracy—verified by good waveform and signal strength.

What things can create inaccurate pulse oximeter readings?

Certain IV dyes, such as methylene blue, can affect the readings. Methylene blue will give falsely low readings due to excess absorption of the Red wavelength.

Nail polish, especially violets and blues, can also reduce the reading due to the same absorption. Removal of nail polish is always recommended.

Long nails, and artificial or acrylic nails can interfere with good LED/ detector opposition through the tissue.

Patients with deeply pigmented skin may be difficult to monitor, although finger pigmentation is usually less than the rest of the body.

Patients with sickle cell anemia undergoing a sickling crisis may have erroneous readings due to the absorption spectrum of HbS being different than for normal adult Hb.

Severely jaundiced patients have high levels of bilirubin in their blood. A product of bilirubin metabolism is CO2 and thus high levels of carboxyhemoglobin can be formed, causing the oximeter to read artificially high SPO2.

Patients with severe anemia can have low SPO2 readings.

Patients with heavy smoke inhalation can have transiently high CO2 levels and thus a high amount of carboxyhemoglobin.

Certain antibiotics, such as the sulfas, can create high levels of methemoglobin. Methemoglobin is unable to bind O2 and will absorb light similarly to reduced hemoglobin, thus giving an artificially low SPO2.

What does electrosurgical interference look like and how can it be minimized?

Electrosurgical interference is most obvious on the displayed waveform. It is a very spiky, erratic looking waveform caused by the electrosurgical unit's overwhelming interference in the OR. It can result in grossly inaccurate pulse oximeter parameters.

Electrosurgical interference can be minimized by:

1. Making sure the pulse oximeter probe is as far away from the return pad and operating site as possible.
2. Making sure the probe is not between the return pad and operating site.
3. Keeping the power cord and probe cable away from the power cord of the electrosurgical unit.
4. Plugging the electrosurgery unit into a separate set of outlets from the monitor.

NOTE

This section is not applicable to monitoring SpO2 with the Masimo SET module and probes, or with Tram x51M modules.

What does motion artifact look like, what problems can it cause, and how can it be corrected?

Motion artifact occurs with excessive motion of the probe, the cable leading to the probe or the cable/probe junction. In other words anything that causes any of these things to move, like the patient moving his hands, or the cable lying across the ventilator tubing and being moved with every cycle, can cause motion artifact. A non-arterial, often erratic looking waveform and a pulse rate that does not coincide with the HR on the ECG will result.

The main problem motion artifact can cause is erroneous SPO2 readings.

Motion artifact can be reduced, if not eliminated, by selecting a “quieter” site on the patient. An ear probe if he refuses to keep his hands still, or an adhesive probe on the toe, an adhesive probe on the little finger for an adult, or on the sole of the foot in a newborn, can help greatly.

Cable movement can be reduced by applying the probe with the cable leading toward the patient, then taping the cable to the side of the hand or foot. In the case of the butterfly probe, the tape was designed to secure the cable to the finger.

For your notes

15 Cardiac Output

For your notes

Introduction

NOTE

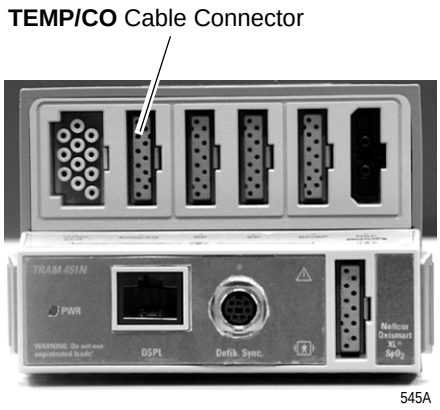
This option is part of the Cardiopulmonary software package.

The cardiac output (CO) program measures cardiac output by use of a thermodilution catheter, with information processed by a Tram module or a BP/CO module. A numeric value and, during measurement, a real-time cardiac output washout curve are displayed on the monitor. The program allows you to perform multiple measurements and to delete those not wanted. Up to four measurements are retained. The program will automatically average these and, when saved, enter the averaged values into cardiac calculations and vital signs.

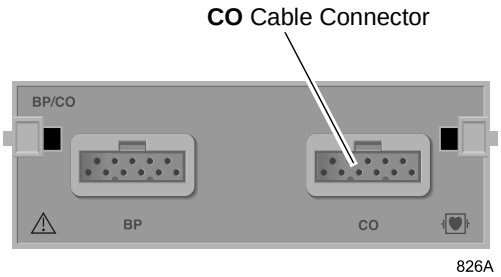
Connect the cardiac output patient cable to the **TEMP/CO** connector on the front of the Tram module, or the **CO** connector on the BP/CO module.

NOTE

The connector on the Tram module is used for both temperature monitoring and cardiac output measurements, but they cannot be monitored at the same time. When using a Tram module for cardiac output, you need a separate temperature module to do temperature monitoring.



Tram 451N Module



BP/CO Module

NOTE

The BP/CO module must be used with a Solar ECG/Resp module.

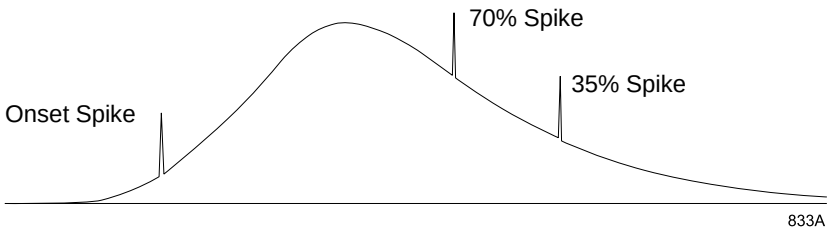
NOTE

The signal input is a high-insulation port and it is defibrillator-proof ( ).

The insulated input ensures patient safety and protects the device during defibrillation and electrosurgery.

Cardiac Output Washout Curve

The washout curve, which appears on the screen after a CO injection, shows the drop in blood temperature as the injectate mixes with the blood. The peak of the curve indicates the maximum difference in the patient's baseline blood temperature and the temperature of the injectate solution. As the mixture passes through the catheter and then out the pulmonary artery, the temperature difference decreases as indicated by the curve returning to the baseline. A spike is displayed at the onset of the curve, again at 70% of the maximum temperature difference, and again at 35% of the maximum temperature difference. This curve is reproduced in reduced size at the top of the trial chart.



Cardiac Output Washout Curve

Influencing Factors

Some of the factors that affect cardiac output are:

- The technique used in performing a cardiac output
- Temperature of the injectate solution
- Volume of injectate solution
- Patient's baseline blood temperature
- Patient's inspiratory/expiratory cycle
- Placement of catheter with relation to proximity of lung field
- The swan ganz catheter itself
- The patient's rhythm and hemodynamic status
- Any other rapid IV solutions which are infused while the cardiac output is being performed

Technique

Below are suggestions about technique that can help obtain accurate cardiac output:

- Always hold the syringe by the plunger, not the barrel.
- Injectate solution must be cooler than the patient's blood temperature.
- Inject solution rapidly and smoothly.
- Inject over 4 to 5 seconds.
- Inject at end expiration.
- Wait 1 minute between injections to allow baseline to stabilize.

Suggested Cardiac Output Procedure

Following is a summary of the entire cardiac output procedure. It is provided to give you an overall picture of the process. The rest of the chapter includes details and additional information that you should read. This suggested procedure can be a handy reference once you are familiar with the details.

1. Determine whether an in-line sensor or bath probe sensor is being used for cardiac output. Set up cables and prepare the patient accordingly. (Refer to the setup diagrams in this chapter.)
2. Select the CO parameter label on the monitor. Depending on the mode, you will see one of two messages: *"INJECT WHEN READY,"* or *"PUSH CO NOW OR TURN AUTO ON."* The CO menu and a cardiac output trials chart are also displayed.
3. Adjustments can be made at this time using the menu options provided. Adjustments you may need to make include:
   a. Type of injectate temperature probe—in-line or bath probe
   b. Injectate volume
   c. Use of PAW, PAD, or LA in cardiac calculations
   d. Catheter size
   e. Computation constant

   NOTE
   If *"UNSTABLE BT DETECTED"* message is displayed, the monitor cannot detect an injection. Refer to the Troubleshooting section in this chapter.
4. When adjustments are complete, you can proceed. If the message reads *"INJECT WHEN READY,"* proceed with the injection.

   If the message reads *"PUSH CO NOW OR TURN AUTO ON,"* you must either select C*ARDIAC OUTPUT NOW* or select *AUTO MODE* and turn it *ON*. Then watch for the *"INJECT NOW!"* message. Inject when you see the message.

   A few seconds after injecting, the washout curve begins to move across the screen and the message *"COMPUTING CO"* is displayed.

5. If you want a copy of the washout curve, select the *PRINT CO CURVE* option (do not use the **Graph Go/Stop** button) when the curve is displayed on the screen.

   The curve will continue to move across the screen. Soon the message *"CO COMPLETE"* is displayed with a CO value. A manual graph of the curve (if requested) is printed. In addition, the first column in the chart is filled with values relevant to the cardiac output just performed. Note also that an average is displayed in the *AVG* column.

6. Perform another injection when prompted. You can do as many injections as you want; however, the monitor only retains four. When a fifth injection is done, the first is deleted, etc.

7. When all injections are done, select the *DELETE CO TRIALS* option if you want to edit (delete) any of the displayed trials. The monitor will recalculate the average CO.

8. If you want a printed copy of the cardiac output trials information, press the **Graph Go/Stop** button on the keypad.

   NOTE

   The washout curves on the screen's chart do not print with the rest of the information.

9. When editing is complete, select the *CARDIAC CALCS* option. The cardiac output information window is replaced with the cardiac calculations information window. The average from the cardiac output trials appears in the list of calculations.

10. If necessary, use the *CHANGE VALUE* option to edit any of the monitored parameter values.

11. Press **Graph Go/Stop** button if you want a copy of this set of cardiac calculations.

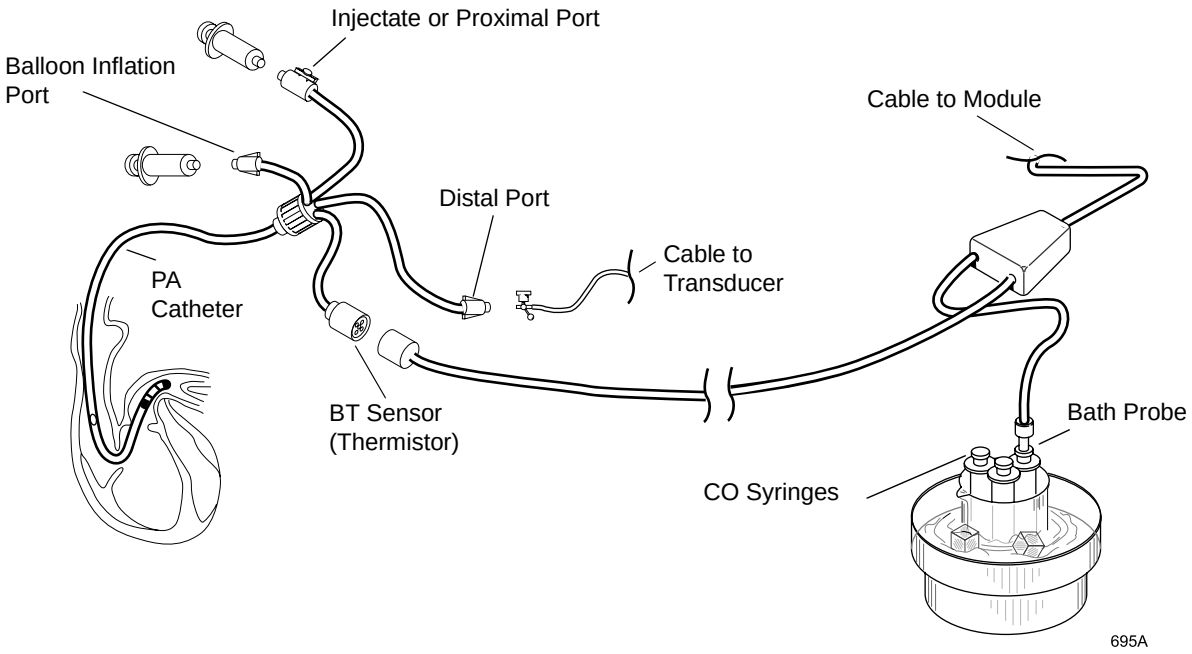
12. **IMPORTANT**—When satisfied with the set of cardiac calculations, select the *SAVE CALC* option. This stores the set of calculations. You can view all saved sets in vital signs.

13. Select *REVIEW CALCS* to enter the vital signs program and see the cardiac calculations data.

Checklist

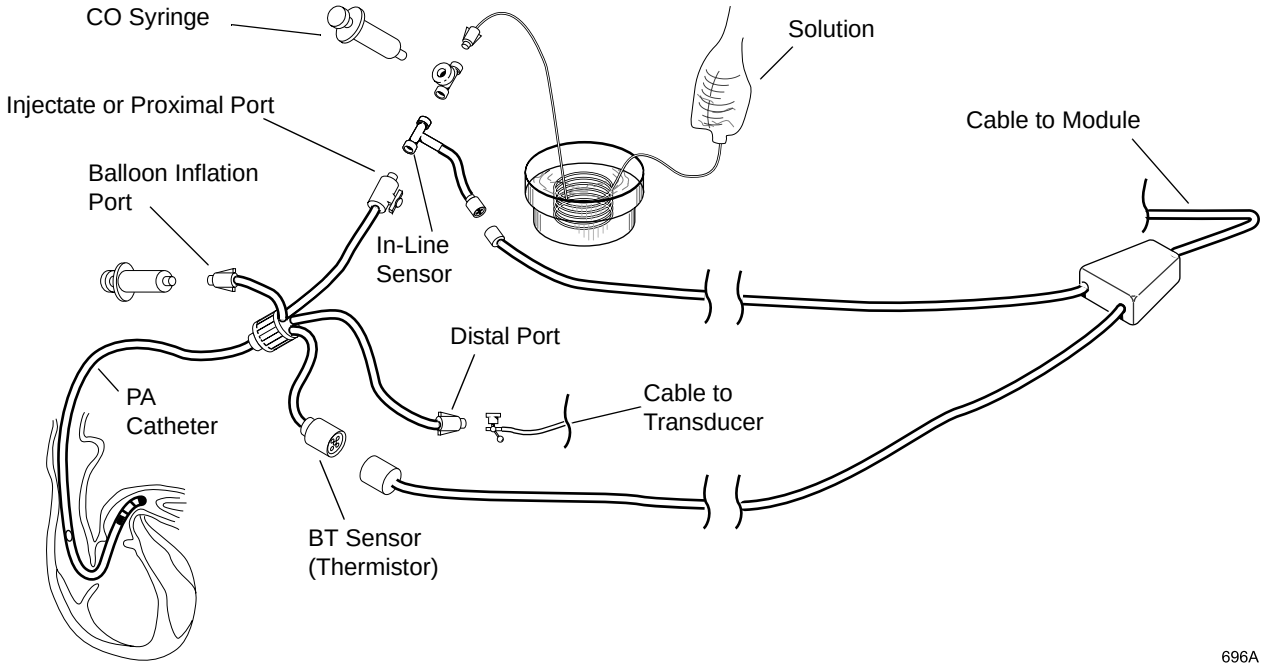
1. The module is securely inserted in the Tram-rac housing.
2. Catheter is in place in the patient.
3. Cardiac output cable is connected to the module.
4. Depending on your setup choice, be sure that:
   - In-line sensor is securely connected to tubing, or
   - Bath probe is correctly sensing injectate temperature.
5. Cardiac output default settings are adjusted, if necessary. Follow the detailed procedures within this chapter.

Bath Probe Setup



Cable Setup for Bath Probe Sensor

In-Line Setup

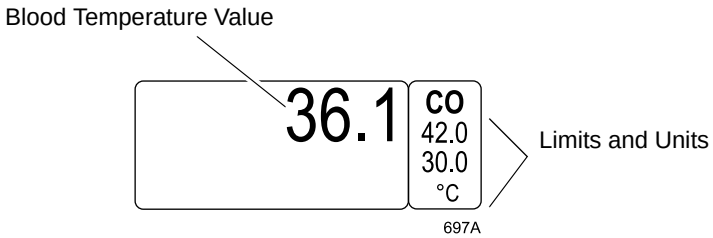


Cable Setup for In-Line Sensor

Cardiac Output Monitoring Features

Cardiac Output Information

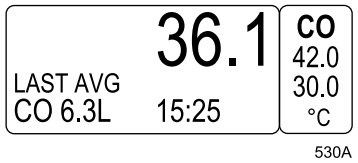
When the cardiac output cable is attached to the module, a CO parameter window is displayed. A CO waveform is displayed only during the injection procedure.



CO Parameter Label and Windows

The parameter window displays the patient's blood temperature. Blood temperature limits and units of measure may also be displayed.

After you have completed a set of cardiac output trials, entered cardiac calculations, and performed a save calc procedure, the last average CO value, along with a time stamp, is displayed in the parameter window.



CO Parameter Label and Windows

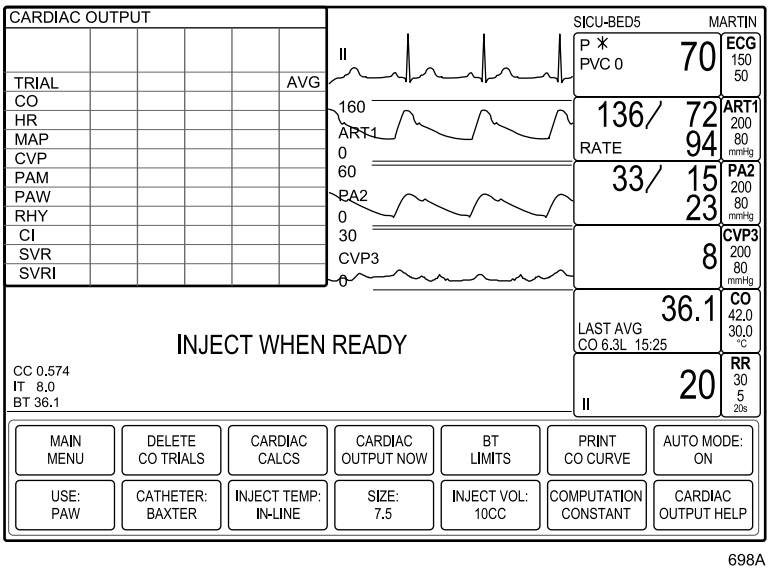
The CO monitoring features are found in the CO menu. Refer to the Cardiac Output Menu Options section in this chapter for more information.

NOTE

A cardiac output measurement (injection) is also referred to as a cardiac output trial.

Cardiac Output Trials

Enter the Cardiac Output program by selecting the *CO* label on the display, or with the **Cardiac Output** button found on the Adult and Operating Room keypads and remote controls. A display similar to the one below appears.



Cardiac Output Auto Mode

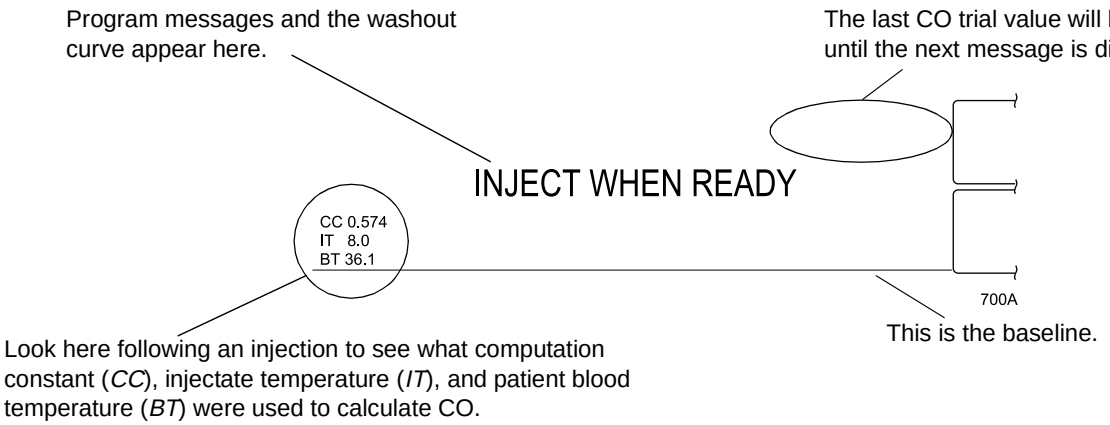
The patient display automatically shifts to the individual display mode. The fifth and sixth waveform displays are cleared, and this space is dedicated to the cardiac output waveform. An information window is displayed, where the cardiac output trial information can be viewed. Upon exiting the program, the display returns to the previous configuration.

For each cardiac output trial, the information window displays a review CO curve, the derived CO value, the patient's heart rate, and other vital signs at the time of the cardiac output. Any cardiac rhythm disturbances (row labeled *RHY*) are also noted. Additionally, if the patient's height and weight have been entered in cardiac calcs, other calculated parameters, for example, *CI*, are displayed. (To view all calculated parameters, you need to enter cardiac calculations.)

NOTE

The last average CO value and time are cleared from the parameter window after the first new CO trial is completed.

Detailed information about the area of the screen where the waveform is displayed appears below.


Program messages and the washout curve appear here.
The last CO trial value will be displayed here until the next message is displayed.
INJECT WHEN READY
CC 0.574
IT 8.0
BT 36.1
700A
This is the baseline.
Look here following an injection to see what computation constant (*CC*), injectate temperature (*IT*), and patient blood temperature (*BT*) were used to calculate CO.

CO Screen Information

If Auto mode is on and a stable baseline is detected, the *"INJECT WHEN READY"* message is displayed. Make your injection when you are ready. If necessary, you can make adjustments to the injectate volume, temperature, catheter, and catheter size before beginning an injection. (Refer to the procedures for these options in this chapter.)

If the manual mode is on, the message *"PUSH CO NOW OR TURN AUTO ON"* is displayed. You must either select the Cardiac Output Now option or the Auto Mode option to proceed.

This is what occurs on the display as an injection is made:

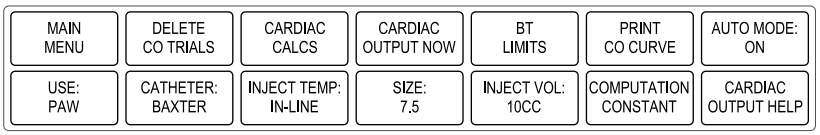
1. The message *"COMPUTING CO"* is displayed, and the real-time cardiac output washout curve begins to move across the screen.
2. The message *"CO COMPLETE"* is displayed with the CO value.
3. The first blank column in the information window is filled with values obtained from the cardiac output procedure. A miniature version of the washout curve is shown above the column.

Getting to the Cardiac Output Menu

To display the CO menu, select the *CO* parameter label. The CO menu is displayed at the bottom of the screen. You can perform a cardiac output trial when ready, or select any menu option.

NOTE

If you have an Adult or Operating Room keypad or remote control, you can also access the CO menu with the **Cardiac Output** button.



Cardiac Output Menu

- *DELETE CO TRIALS* — Deletes those trials that are not acceptable.
- *CARDIAC CALCS* — Enters the cardiac calculations program.
- *CARDIAC OUTPUT NOW* — Performs one measurement each time this option is selected. Use this option when the auto mode is off.
- *BT LIMITS* — A new menu is displayed with an information window to adjust blood temperature limits. There is also a menu option to change units between Celsius and Fahrenheit.
- *PRINT CO CURVE* — Prints a copy of the cardiac output washout curve.
- *AUTO MODE* — Turns Auto Mode off and on.
- *USE: PAW** — Select *PAW*, *PAD*, or *LA* to be factored in the cardiac calculations.
- *CATHETER** — Selects the catheter type.
- *INJECT TEMP** — Selects the injectate temperature probe (in-line or bath).
- *SIZE** — Changes the catheter French size.
- *INJECT VOL** — Adjusts the injectate volume.
- *COMPUTATION CONSTANT** — Used to enter a different computation constant.
- *CARDIAC OUTPUT HELP* — Displays an information window with troubleshooting information.

* Changing these after one or more trials have been performed will erase the trials.

Detailed information on each option in found in this chapter.

Cardiac Output Menu Options

Delete CO Trials

The monitor displays up to four cardiac output trials. If a fifth trial is made, the oldest trial is deleted, and so on. The *AVG* (average) column keeps a running average of the displayed cardiac output trials. You can delete any or all of the displayed trials. Follow these steps.

1. Select the *DELETE CO TRIALS* option from the Cardiac Output menu. A popup menu opens. The numbers shown in the popup menu correspond to the numbers at the top of each column in the trials window.
2. Select the trial number you wish to delete. The number highlights, and the popup menu remains open so you can select additional trials to delete, if desired.

   If you decide you do not want to delete a highlighted trial, simply select it again to unhighlight (deselect) it.
3. When you have selected (highlighted) all the trials you want to delete, select *RETURN* to close the popup menu and delete the trials from the Cardiac Output Trials window.
4. Select the *CARDIAC CALCS* option. (Refer to the Cardiac Calculations section in this chapter.)

Cardiac Calcs

Refer to the Cardiac Calculations section in this chapter.

Cardiac Output Now

Use the Cardiac Output Now option when Auto Mode is off.

When Auto Mode is off, the monitor does not search for a stable baseline. Therefore, you decide when to begin the injection procedure. When you are ready, select *CARDIAC OUTPUT NOW* and inject when you see the "*INJECT NOW!*" message. This mode may be preferred for patients with extreme blood temperature fluctuations.

With this option, it is particularly important that you inject immediately upon seeing the "*INJECT NOW!*" message. If you wait too long to make the injection, the monitor will cycle itself and the message "*PUSH CO NOW OR TURN AUTO ON*" is displayed again.

Follow this procedure to use the Cardiac Output Now option:

1. Select the *CARDIAC OUTPUT NOW* option from the Cardiac Output menu.
2. Watch for the "*INJECT NOW!*" message, then make your CO injection.
3. The "*COMPUTING CO*" message is displayed, and the cardiac output waveform begins to move across the screen.
4. The message "*CO COMPLETE*" is displayed with the new CO value.

BT Limits

Select the *BT LIMITS* option to open an information window and a new menu, which allow you to adjust the following:

- BT high and low limits
- Units (see below)

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

Units

This direct action menu option switches the units of measurement for blood temperature and injectate temperature between Celsius and Fahrenheit.

Print CO Curve

Selecting this option prints the real-time cardiac output curve to the designated manual graph location. The request for a print can be made any time during the measurement process. This is a direct action menu option.

The message "*GRAPHING MANUAL*" is displayed when the waveform is printing. If you don't see the message immediately, it simply means you requested the graph early in the process. The monitor retains your request and will start printing when the measurement is complete.

NOTE

If you press the **Graph Go/Stop** button during a measurement, only the information window data is printed. You must select the *PRINT CO CURVE* option to print the washout curve.

Auto Mode

Select the *AUTO MODE* menu option to open a popup menu from which you can turn the Auto Mode off and on. This can be set as a monitor default. The factory default is On.

When Auto Mode is on, the monitor automatically searches for a stable baseline temperature by averaging approximately 8.5 seconds of the patient's blood temperature. Once a stable baseline is established, the message "*INJECT WHEN READY*" is displayed, and you can proceed.

Use: PAW (PAD, LA)

This option allows you to select one of three pressure values — pulmonary artery wedge (*PAW*), pulmonary artery diastolic (*PAD*), or left atrial (*LA*) — to be used in the calculations.

Select *PAW*, *PAD* or *LA*. The popup menu closes and the change takes effect.

NOTE

It is recommended that you adjust the pressure selection before an injection is begun. If you make a change after one or more cardiac output trials have been done, the trials will be deleted. This does not affect any calculations already saved.

Catheter

Use this option to change catheter types. Selecting another catheter type causes the monitor to automatically guide you through the Inject Temp, Size, and Inject Vol options to assure that your setup is the one you want. You do not need to enter a computation constant because the software calculates one based on the manufacturer selected and the temperature, size, and volume settings. The computation constant appears in the Cardiac Output window after the first CO injection is complete.

NOTE

It is recommended that a catheter change be made before an injection is begun. If you make a change after one or more cardiac output trials have been done, the trials will be deleted. This does not affect any calculations already saved.

Select *CATHETER* from the CO menu. A popup menu opens. Choices are: *BAXTER, ABBOTT, OHMEDA, ARROW,* and *OTHER*. Select the manufacturer of choice. The monitor automatically opens the Inject Temp, Size, and Volume popup menus.

NOTE

Selecting *OTHER* opens the Computation Constant popup menu. You must manually enter the computation constant found in the literature for the catheter you are using.

Injectate Temperature

The temperature of the injectate is determined by the type of sensor used, either in-line or bath probe. It is important to have the monitor set for the type of sensor being used to assure a valid CO reading. Changing this option causes the monitor to calculate a new computation constant when the next trial is done.

To change this option, select *INJECT TEMP* from the CO menu. A popup menu opens, displaying the options *IN-LINE* and *BATH PROBE*. Select an option.

NOTE

It is recommended that you make this adjustment before an injection is begun. If you make a change after one or more cardiac output trials have been done, the trials will be deleted. This does not affect any calculations already saved.

Size

This option allows you to select the catheter size. Changing this option causes the monitor to calculate a new computation constant when the next trial is done.

To change this option, select *SIZE* from the CO menu. A popup menu opens. Options are: *8, 7.5, 7, 6,* and *5*. Select an option.

NOTE

It is recommended that you make this adjustment before an injection is begun. If you make a change after one or more cardiac output trials have been done, the trials will be deleted. This does not affect any calculations already saved.

Injectate Volume

When using a Baxter, Abbott, Ohmeda, or Arrow catheter setup, changing this option causes the monitor to calculate a new computation constant when the next trial is done.

To change the injectate volume, select *INJECT VOL* from the CO menu. A popup menu opens, displaying the options *10CC*, *5CC*, and *3CC*. Select an option.

NOTE

It is recommended that you make this adjustment before an injection is begun. If you make a change after one or more cardiac output trials have been done, the trials will be deleted. This does not affect any calculations already saved.

Computation Constant

This option is used for brands of catheters other than those listed in the catheter option. Consult the catheter manufacturer's package insert to find the recommended computation constant.

Select *COMPUTATION CONSTANT* from the CO menu. A popup menu opens.

Use the number buttons on the keypad or remote control, rotate the Trim Knob control, or use the touchscreen arrows to change the number displayed in the popup menu. Press the Trim Knob control or touch the *COMPUTATION CONSTANT* option to confirm the change and close the popup menu.

The CC value displayed on the left in the waveform area does not reflect the change until the first cardiac output trial is complete. The catheter menu option reads *CATHETER: OTHER*.

NOTE

If you select this option and make a change after one or more cardiac output trials have been done, the trials will be deleted. This does not affect any calculations already saved.

The computation constant reads *0.000* when the cable is first connected and prior to the first injection. If you manually set this option to *0.000*, you will not be able to complete a cardiac output trial.

When you manually enter a computation constant, the other menu options (Inject Vol, Inject Temp, and Size) are not needed. You may change them to reflect your setup, but they have no effect on the software.

Cardiac Output Help

Selecting this option opens a popup menu and an information window. The information window contains technique tips, as well as some possible reasons for an unstable baseline message. Press the Trim Knob control or use the touchscreen to close the popup menu and the information window.

Cardiac Calculations

Introduction

The cardiac calculations program displays important hemodynamic parameter values. These parameters are separated into two classifications: monitored parameters and calculated parameters. A menu is provided to change or enter a monitored parameter value.

Monitored Parameters

The monitored parameter values are obtained from available monitored patient data. Only weight and height values must be entered manually.

The chart below shows the monitored parameters, the labels used to identify these parameters on the screen, and the units of measure.

Monitored Parameters

Parameter	Label	Units
Cardiac Output	*CO*	*L/MIN*
Heart Rate	*HR*	*BPM*
Mean Arterial Pressure	*MAP*	*mmHg*
Central Venous Pressure	*CVP*	*mmHg*
Pulmonary Artery Mean	*PAM*	*mmHg*
Pulmonary Artery Wedge*	*PAW*	*mmHg*
Pulmonary Artery Diastolic*	*PAD*	*mmHg*
Left Atrial*	*LA*	*mmHg*
Weight	*WEIGHT*	*KG* or *LBS*
Height	*HEIGHT*	*CM* or *INCHES*

* Menu selectable; only one is used at a time

Calculated Parameters

The calculated parameter values are figured automatically. The chart below shows the calculated parameters, the labels used to identify these parameters on the screen, the units of measure, and the formulas used.

Parameter	Label	Unit	Formula
Body Surface Area	BSA	m^2	$HT^{0.725} \times WT^{0.425} \times 0.007184$
Cardiac Index	CI	$L/min/m^2$	$\frac{CO}{BSA}$
Stroke Volume	SV	mL/beat	$\frac{CO}{HR} \times 1000$
Systemic Vascular Resistance	SVR	$dyn \cdot sec/cm^5$	$\frac{(MAP - CVP) \times 79.92}{CO}$
Systemic Vascular Resistance Index	SVRI	$dyn \cdot sec \cdot m^2/cm^5$	SVR x BSA
Pulmonary Vascular Resistance	PVR	$dyn \cdot sec/cm^5$	$\frac{(PAM - PAW) \times 79.92}{CO}$ *
Pulmonary Vascular Resistance Index	PVRI	$dyn \cdot sec \cdot m^2/cm^5$	PVR x BSA
Left Ventricular Stroke Work Index	LVSWI	$g \cdot m/m^2$	$\frac{SV \times (MAP - PAW) \times 0.0136}{BSA}$ *
Right Ventricular Stroke Work Index	RVSWI	$g \cdot m/m^2$	$\frac{SV \times (PAM - CVP) \times 0.0136}{BSA}$

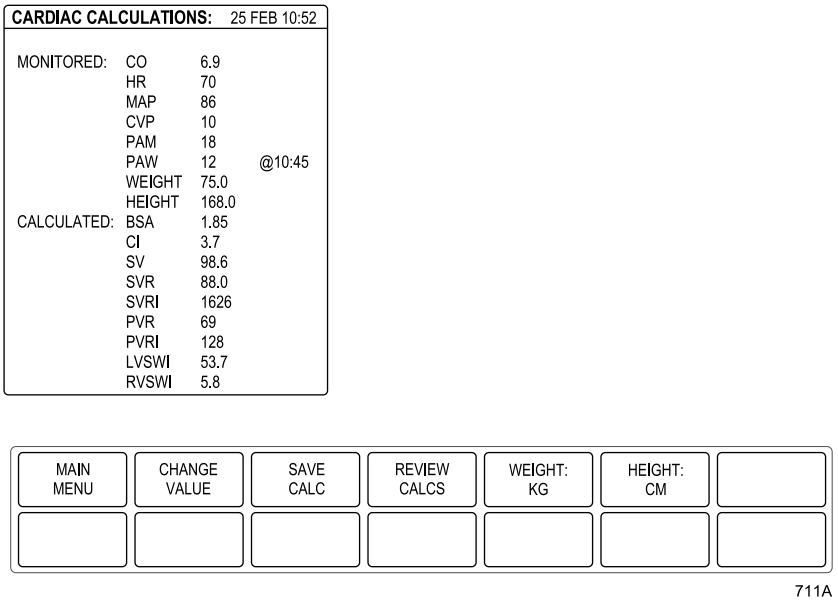
* If using pulmonary artery diastolic (PAD) pressure or left atrial (LA) pressure, PAW will be substituted with PAD or LA.

Cardiac Calcs

To enter the cardiac calculations program upon completion of cardiac output trials, select the *CARDIAC CALCS* option from the CO menu. An information window is displayed on the screen and a new set of menu options is displayed in the menu area.

NOTE

If you have an Adult or Operating Room keypad or remote control, you can also access Cardiac Calcs using the **Cardiac Calcs** button.



Cardiac Calcs Menu and Information Window

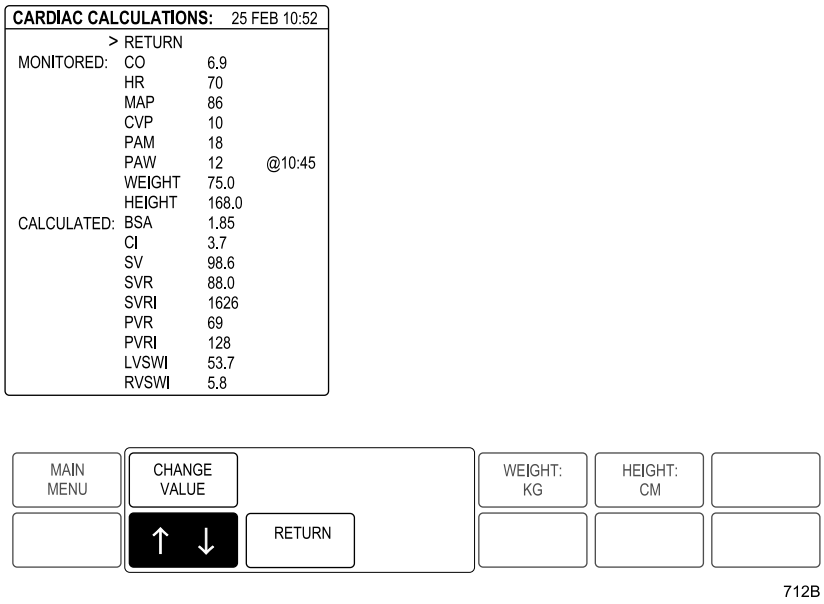
The information window displays the monitored and calculated parameter values relating to your last cardiac output trial.

You now can select any of the displayed options:

- *CHANGE VALUE* — Enter or change a monitored value.
- *SAVE CALC* — Saves the set of calculations; can be reviewed in vital signs.
- *REVIEW CALCS* — Enter Vital Signs to review all saved calcs.
- *WEIGHT* — Changes the units of measure for Weight between kilograms and pounds.
- *HEIGHT* — Change the units of measure for Height between centimeters and inches.

Change Value

When this option is selected, you can change values (or enter new values) for the monitored parameters. Select the *CHANGE VALUE* option from the Cardiac Calcs menu. A popup menu opens and a pointer (>) and the *RETURN* option are displayed at the top of the information window.



Change Value Popup Menu

To change a value in the Cardiac Calculations window, use the *CHANGE VALUE* option and follow the procedure described in the Selecting Options from Scroll Lists section in Chapter 1, The Basics.

Save Calc

Selecting the *SAVE CALC* option saves the calculation and enters the appropriate values into Cardiac Calcs and Vital Signs. This is a direct action menu option.

NOTE

The monitor saves 20 cardiac calculations. These saved calculations are not limited to a 24-hour time period.

Weight

Selecting the *WEIGHT* option switches the units of measure for Weight between kilograms and pounds. This is a direct action menu option.

Height

Selecting the *HEIGHT* option switches the units of measure for Height between centimeters and inches. This is a direct action menu option.

Troubleshooting

Procedural Prompts and Messages

During the injection procedure you may see some of the following prompts and messages displayed on the screen. They are listed alphabetically.

CO COMPLETE

The numeric value of the CO has been calculated and is displayed on the screen.

COMPUTING CO

CO waveform has been displayed and now the monitor is preparing the numeric results.

INJECT NOW!

The stat (*CARDIAC OUTPUT NOW*) option has been selected. Make your injection immediately.

INJECT WHEN READY

The Auto Mode is on and the monitor has detected a stable baseline temperature. Make your injection when ready.

PLEASE WAIT

The monitor is searching for a stable baseline temperature.

PUSH CO NOW OR TURN AUTO ON

Auto Mode is off. You can use the *CARDIAC OUTPUT NOW* menu option, or turn Auto Mode on with the *AUTO MODE* menu option.

Error Messages

CO IS TOO LOW TO DISPLAY or *CO IS TOO HIGH TO DISPLAY*

The cardiac output range that the monitor is able to calculate is 0.2L to 20L.

NO CO DUE TO BT SENSOR FAIL

A cable may be loose or there is a hardware failure.

NO CO DUE TO IT SENSOR FAIL

A cable may be loose or there is a hardware failure.

UNSTABLE BT DETECTED

The monitor cannot detect a stable baseline temperature. The message clears after 12 seconds only if a stable baseline temperature is found. If message does not clear, check your patient and setup. If message persists, call service or contact your sales/service representative.

The following messages replace the IT or BT values in the CO waveform area. In addition, the BT messages are displayed in the CO parameter window:

BT TOO LOW or *BT TOO HIGH*

Blood temperature is too low or too high or there is a sensor hardware failure.

IT TOO LOW or *IT TOO HIGH*

Injectate temperature is too low or too high or there is a sensor hardware failure.

Problem:
Inaccurate cardiac output values

Solutions:

1. **Technique** — It is important to understand the technique used in performing a cardiac output since it is a major influencing factor in obtaining accurate cardiac output values.

   a. If room temperature solution is used, be sure the bag is not in a heated area in the room and is not touching other solutions or equipment. This is important so the solution temperature will not be different than the room air temperature sensed through the bath or in-line sensor. A temperature difference could give an inaccurate reading.

   b. When doing an injection, always hold the syringe by the plunger and not by the barrel. The temperature of the solution increases at a slower rate if the barrel is not held in the palm of the hand and, therefore, reduces the amount of error in a cardiac output value.

   NOTE

   When in-line is being used along with iced injectate, the initial temperature displayed will be the room temperature. However, when the solution is injected, the temperature displayed will decrease.

   c. It is recommended to inject rapidly and smoothly into the proximal port of the Swan-Ganz catheter, usually within 4 to 5 seconds.

   d. Allow at least 1 to 1-1/2 minutes between injections to allow the baseline to stabilize.

   e. It is also recommended to inject at the patient's end expiration. This helps to reduce any respiratory noise and therefore lessen error.

   f. A minimum temperature difference of 10° is recommended between the patient temperature and solution temperature.

2. **Respiration** — The patient's inspiratory/expiratory cycle and placement of the catheter affects the cardiac output value. Whenever the patient inhales and exhales, the thermistor at the tip of the catheter senses a change in the patient's blood temperature. Therefore, placement of the catheter with relationship to proximity of the lung fields affects the baseline. During inspiration, the patient's blood temperature decreases and during expiration it increases.

   If there is a significant amount of respiratory noise on the patient's baseline, the monitor may try to calculate a cardiac output even if no injection was performed. This is because the monitor does not differentiate between breaths and injections. It looks for a change in baseline temperature.

   a. If patient is alert, have him/her exhale and hold for injection.

   b. Check catheter placement.

3. **Baseline blood temperature** — As little as a half a degree Celsius change in blood temperature, due to respiratory noise, may cause a CO value to be displayed when an injection has not been performed. Using Auto Mode allows the monitor to look for a stable baseline before allowing an injection.

4. **Swan-Ganz catheter** — The catheter itself may be damaged (e.g., defective thermistor or defective tubing).

5. **Hemodynamics** — The patient's rhythm can affect the cardiac output value. If cardiac output trials are being done at a time when the patient has dysrhythmias, you may notice a discrepancy in the cardiac output values.

6. **Rapid IV solutions** — Any rapid IV solution which is infusing at the time when the solution is injected can alter the cardiac output value. Maintain a constant rate, or if possible, stop the solution 30 seconds before the CO injection and then restart the infusion after the cardiac output is calculated.

7. **IT temp fluctuation** — If the IT temp is fluctuating, check the IT cable connection.

Problem:
Cardiac output value lower than expected

Solution:

1. Decrease the volume injected.
2. Increase the temperature of the injectate.

NOTE

Cardiac output must be computed within 20 seconds. Decreasing the volume and increasing the temperature will give you a smaller differential change and should increase the chance of computing a cardiac output within the 20-second period.

Problem:
Cardiac output value higher than expected

Solution:

1. Increase the volume injected.
2. Decrease the temperature of the injectate.

NOTE

Cardiac output must be computed within 20 seconds. Increasing the volume and decreasing the temperature will give you a greater differential change.

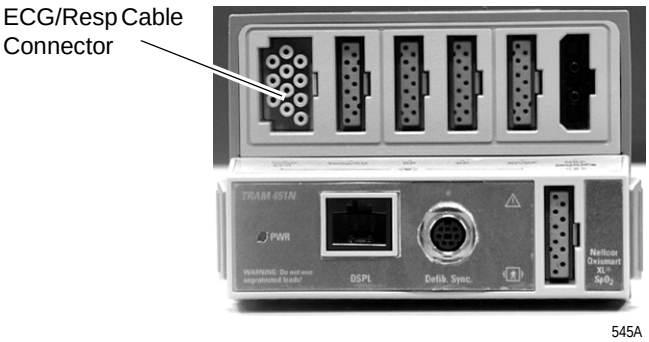
16 Respiration

For your notes

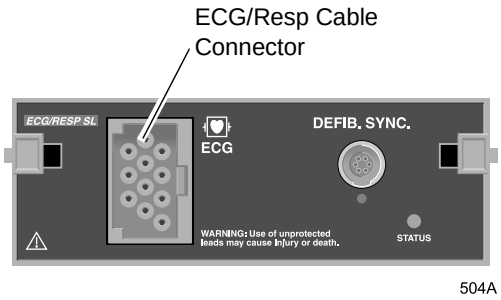
Introduction

Respiration monitoring can be done with any Tram module, any Solar ECG/Resp module, and the ECG cable. Refer to Chapter 11, ECG, for patient preparation and electrode placement.

This chapter gives guidelines for adjusting respiration setup and troubleshooting. The illustrations below show the locations of the respiration connectors on the Tram and Solar modules.



Tram 451N Module



Solar ECG/Resp SL Module

NOTE

When monitoring CO2, a respiration rate is always displayed in the CO2 parameter window. If monitoring CO2, you may not want to monitor respiration by the impedance method as described in this chapter. Refer to Chapter 19, CO2, for more details.

NOTE

The signal input is a high-insulation port and it is defibrillator-proof ( ).

The insulated input ensures patient safety and protects the device during defibrillation and electrosurgery.

NOTE

Respiration monitoring is not adversely affected by the use of an ESU ECG filter.

General Information

WARNINGS

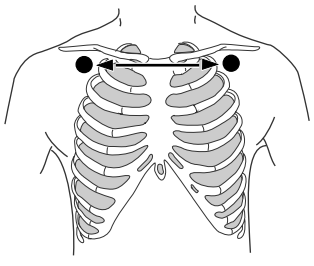
APNEA EVENTS — The monitor may not detect all episodes of inadequate breathing, nor does it distinguish between central, obstructive, and mixed apnea events.

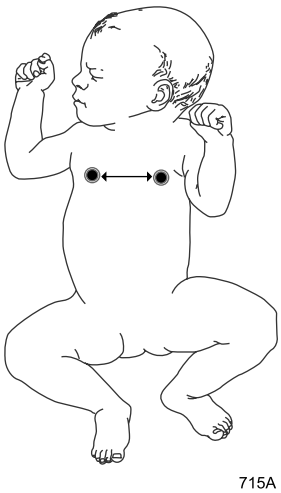
ELECTRODE CONFIGURATION — Impedance respiration monitoring is not reliable when ECG electrodes are placed on the limbs.

Respiration is detected by measuring thoracic impedance. When respiration is monitored, a small AC signal is applied through ECG lead I or ECG lead II. This AC signal appears between the right arm and left arm electrodes or the right arm and left leg electrodes, depending on the selected ECG lead. The lead selected is dependent on the type of "breather" the patient is. See the figures on the following page.

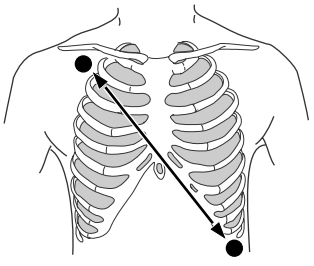
NOTE

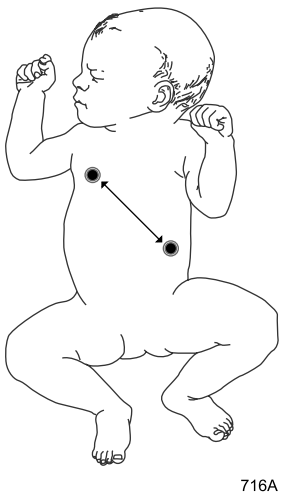
The figures on the following page are used to show the relationship between breathing and ECG lead. They do NOT represent an electrode configuration.





ECG Lead I for Upper Chest Breather





ECG Lead II for Abdominal Breather

After starting respiration monitoring, the monitor "learns" the patient's respiration pattern. Eight breaths are averaged and the average amplitude of the respiration waveform is found. Detection sensitivity is automatically set at 40% of the average amplitude.

NOTE

The message "*LEARNING*" is displayed in the RR values window during this process.

Markers displayed on the waveform show this 40% detection range. One marker is at inspiration, the other at expiration. The detection sensitivity can be manually adjusted by using the sensitivity option in the respiration menu.

The waveform size is also set automatically during the learning process, but may be adjusted if necessary.

NOTE

Respiration detection is not dependent on the size of the waveform. Size is for visual purposes only.

Even though the same electrodes are used for ECG and respiration monitoring, it is possible to get a lead fail message for respiration without one for ECG. The impedance may be too high for respiration detection, but the electrode is still good for ECG. (Refer to the Smart-Lead Fail section in Chapter 11, ECG.)

Checklist

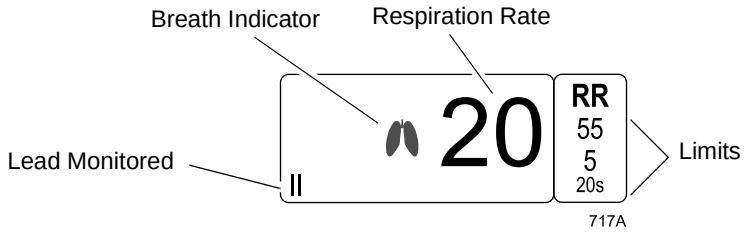
Since respiration monitoring is so closely linked with ECG monitoring, patient preparation and electrode placement are important. Please refer to Chapter 11, ECG, for guidelines.

1. The module is securely inserted in the Tram-rac housing.
2. Electrodes have been placed on the patient following proper skin preparation.
3. Leadwires are attached to electrodes on the patient.
4. Leadwires are connected to the patient cable and the patient cable is connected to the module.
5. Respiration setup is adjusted, if necessary. Follow detailed procedures in this chapter.

Respiration Monitoring Features

Respiration Information

When respiration monitoring is on, a labeled respiration waveform is displayed after the learning process is complete. (Refer to the General Information section in this chapter.) The label includes the ECG lead used to derive the respiration waveform, for example, *RR II*.



RR Parameter Window

The parameter window displays the current respiration rate and the ECG lead used to monitor respiration. A flashing breath indicator (lung symbol) is displayed with each breath detection. Alarm limits may be displayed for respiration rate and apnea.

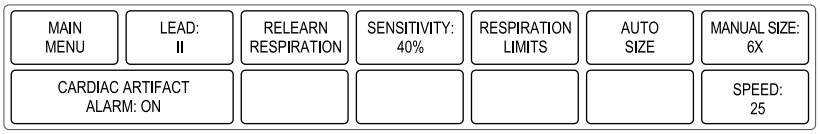
Getting to the Respiration Menu

To display the respiration menu, select the *RR* parameter label.

NOTE

If the parameter label is not displayed, select the *PARAMETERS ON/OFF* option in the Monitor Setup menu to turn respiration on. Then select the *RR* parameter label.

The respiration menu is displayed at the bottom of the screen.



Respiration Menu

- *LEAD* — Changes the lead from which the respiration rate is derived.
- *RELEARN RESPIRATION* — Initiates a monitor relearn of the patient's respiration pattern.
- *SENSITIVITY* — Increases or decreases the sensitivity setting.
- *RESPIRATION LIMITS* — Displays a new menu and an information window to adjust respiration rate and apnea alarm limits.
- *AUTO SIZE* — Automatically sizes the respiration waveform to fit in a predetermined area on the screen.
- *MANUAL SIZE* — Manually increases or decreases the size of the respiration waveform.
- *CARDIAC ARTIFACT ALARM* — Turns the artifact alarm off and on.
- *SPEED* — Changes the sweep speed of the displayed respiration waveform.

Detailed information on each option is found in this chapter.

Respiration Menu Options

Lead

There are two choices for the respiration lead — lead I and lead II. This menu option, when selected, automatically switches the monitored lead for respiration. The label of the lead currently being monitored (I or II) appears in the menu option, the lower left corner of the RR parameter window, and with the waveform label.

Changing leads automatically starts the relearn process.

NOTE

If you are monitoring with a fixed-lead, 3-lead cable, respiration can only be obtained from the lead for which the cable is manufactured. For example, if the cable is a fixed lead II cable, a *"LD I FAIL"* message appears in the RR parameter window if you try to change the respiration lead.

Relearn Respiration

A "learning" process always takes place when respiration monitoring is started. If the patient's breathing pattern changes after the initial learning process has taken place, it may be necessary to relearn.

Select *RELEARN RESPIRATION* from the respiration menu. This is a direct action menu option. The message "*LEARNING"* is displayed in the RR values window. There is no respiration rate displayed during the learning process. When learning is complete, the message will clear and the respiration rate will be displayed.

NOTE

Sensitivity is reset at 40% and the waveform is automatically sized when a relearn procedure takes place.

Sensitivity

During the learning process, the monitor automatically sets the detection sensitivity at 40% of the average amplitude. Markers are displayed on the waveform, showing the detection points at inspiration and expiration.

If you need to change the detection sensitivity because of varying amplitudes or artifact, select the *SENSITIVITY* option from the respiration menu. A popup menu opens, showing the options: *90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%,* and *10%.*

Select a sensitivity percentage. The markers on the waveform will move to reflect the new percentage. The lower the percentage, the greater the detection sensitivity.

Respiration Limits

Select *RESPIRATION LIMITS* to open an information window and a new menu, which allow you to adjust the following:

- Respiration (*RESP*) rate high and low limits
- Apnea limit

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

Auto Size

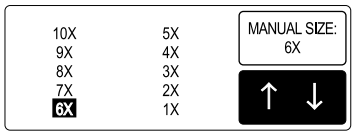
NOTE

The size of the waveform has no effect on the detection capability of the program.

During the learning process, the displayed waveform is automatically sized to fit a predetermined area of the screen. During monitoring, the size may have been changed manually (see the Manual Size section in this chapter). Select the *AUTO SIZE* option to automatically resize the waveform to fit the predetermined area. This is a direct action menu option.

Manual Size

You can manually change the size of the respiration waveform. Select the *MANUAL SIZE* option from the respiration menu. A popup menu opens, displaying the size options.



Manual Size Popup Menu

Highlight another size. The waveform changes size immediately so you can judge the suitable size. When you are satisfied with the size, press the Trim Knob control or touch the *MANUAL SIZE* option to close the popup menu.

NOTE

The Manual Size you select will be cancelled if you change the lead from which respiration is derived. When you change leads, the learning process is started and the waveform is automatically sized.

Cardiac Artifact Alarm

The Cardiac Artifact Alarm alerts you to the fact that the respiration rate is within 5% of the heart rate (over 30 consecutive breaths). If this happens, the respiration program may be counting heartbeat artifact as respiration. The Cardiac Artifact Alarm is an advisory alarm. The message *"ARTIFACT"* is displayed in the respiration values window, and a one-beep tone sounds.

There is no adjustable limit for this alarm, but you can turn it off and on.

WARNING

If the Cardiac Artifact Alarm is turned off, apnea events may not be detected.

To turn the alarm off and on, select the *CARDIAC ARTIFACT ALARM* option from the respiration menu. This is a direct action menu option.

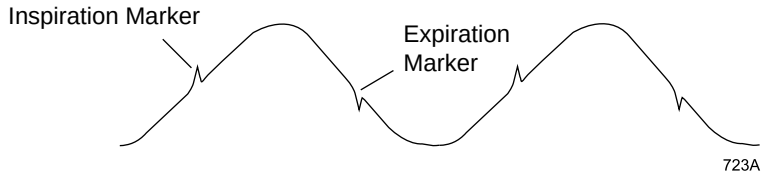
Speed

Use this menu option to open a popup menu to select a sweep speed for the displayed respiration waveform. Choices are 6.25, 12.5, 25 (default), and 50 millimeters per second.

Troubleshooting

Respiratory Waveform

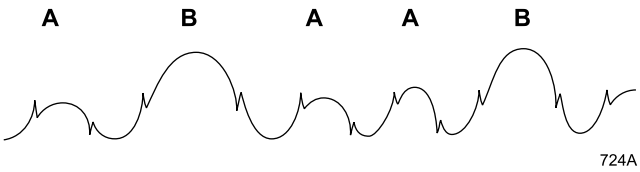
Illustrated below is a respiratory waveform that is regular and even. The inspiration and expiration markers are identified.



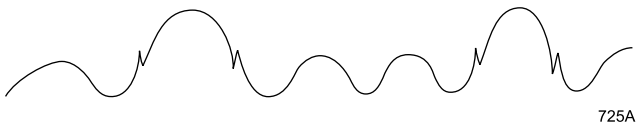
Regular and Even

Cardiac Artifact

In cases where there is cardiac artifact, if the detection sensitivity percentage is set too low, the artifact will be detected as breaths. Increase the detection sensitivity percentage until the markers correctly identify each inspiration and expiration. See the markers in the figures below. (A = artifact, B = breath)



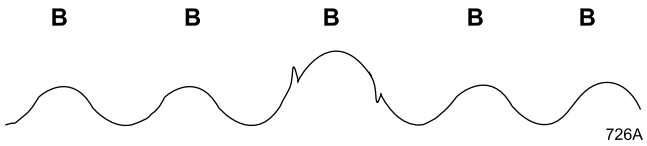
Incorrect Detection



Correct Detection

Varying Amplitudes

Some waveforms show a combination of shallow and deep breaths. If the detection sensitivity percentage is set too high, the shallow breaths will not be detected. Decrease the detection sensitivity percentage until the markers correctly identify each inspiration and expiration. See the markers in the figures below. (B = breath)



Incorrect Detection

Correct Detection

Messages

Below is a list of the messages that may be displayed in the respiration parameter window during respiration monitoring. The message meanings, as well as actions to take, are included. These messages may appear in abbreviated form if the parameter window is sized smaller due to the number of parameters being monitored. The abbreviated form, if there is one, is shown in parentheses.

LEARNING

The monitor takes approximately eight breaths to learn the patient's respiration pattern before displaying a respiration value. Learning automatically occurs whenever respiration is turned on and when the lead from which respiration is monitored is switched.

APNEA

CHECK THE PATIENT. This is an alarm condition that requires action. Breathing has not been detected for a predetermined number of seconds. If necessary, the apnea limit can be changed. Refer to the Respiration Limits section in this chapter.

ARTIFACT

CHECK THE PATIENT. This is an alarm condition that requires action. The monitor is unable to successfully determine respiration. If it is determined that patient condition is not the cause, it may be necessary to re-prep the patient's skin and change the electrodes to resume monitoring of respiration.

LD I FAIL or *LD II FAIL*

CHECK THE PATIENT. This is an alarm condition that requires action. The lead monitoring respiration has failed. You can manually switch respiration detection to the other lead, or it may be necessary to re-prep the patient's skin and change the electrodes.

LEADS FAIL (LDS FAIL)

CHECK THE PATIENT. This is an alarm condition that requires action. It may be necessary to re-prep the patient's skin and change the electrodes.

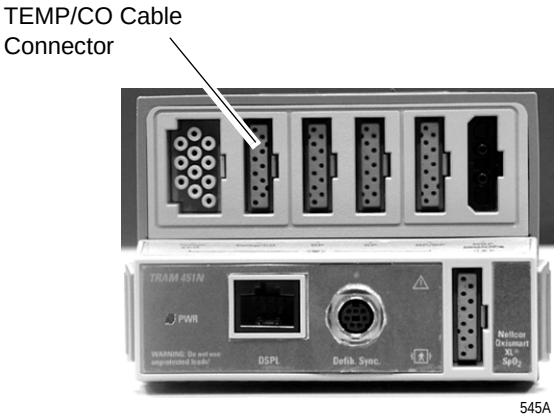
17 Temperature

For your notes

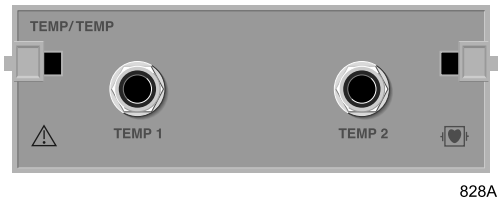
Introduction

Two temperature sites can be monitored with any of the following acquisition modules:

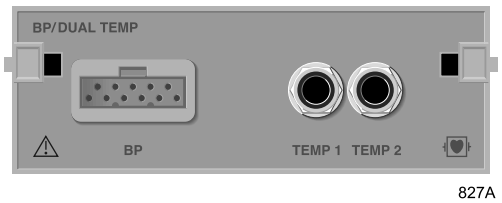
- Tram module (YSI series 400 or 700 probes)
- Dual Temperature module (YSI 700 probes)
- BP/Dual Temperature module (YSI 700 probes)
- Dual Temperature module series 400 (YSI 400 probes)
- BP/Dual Temperature module series 400 (YSI 400 probes))



Tram 451N Module



Dual Temperature Module



BP/Dual Temperature Module

NOTE

The signal input is a high-insulation port and it is defibrillator-proof ( ).

The insulated input ensures patient safety and protects the device during defibrillation and electrosurgery.

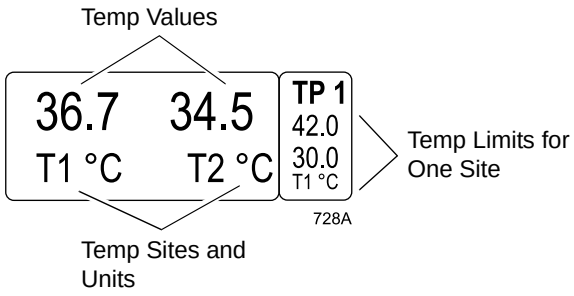
Checklist

1. The module is securely inserted in the Tram-rac housing.
2. The temperature probe(s) is correctly positioned on the patient. (Follow appropriate medical procedures.)
3. The temperature cable switch is turned to 400 or 700 depending on the type of cable used.
4. The temperature cable is attached to the module.
5. The temperature setup is adjusted, if necessary. Follow detailed procedures within this chapter.

Temperature Monitoring Features

Temperature Information

Temperature monitoring provides numerical information only. No waveform is generated or displayed. Numerics are displayed in the temperature (*TP*) parameter window on the right side of the screen.



Temperature Parameter Window

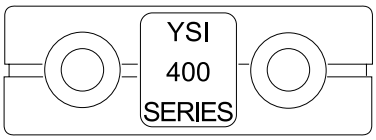
The temperature parameter label has a number with it that corresponds to the slot in the Tram-rac housing where the module is located. The parameter window displays the current temperature values, along with the unit of measurement. If the defaults are set up to display limits, the T1 limits are displayed.

NOTE

When both temperature sites are being monitored, the alarm limits for the T1 site only are displayed in the limits window. If the T1 site is turned off, the displayed alarm limits automatically switch to the T2 alarm limits.

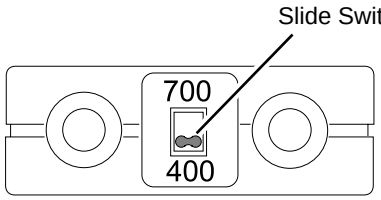
You can monitor a patient's temperature at multiple sites. Both internal and external temperature sensors may be used. The module calculates the monitored temperatures and displays their values on the screen. The temperature sites are identified in the values window as *T1* and *T2*.

The Tram module is compatible with both YSI series 400 and 700 probes. If you are using the dual temperature cable, you must select 400 or 700 (depending on the type of probe) for correct operation. The switch is located on the cable. See the figures below.



729A

YSI 400 Series Temperature Cable



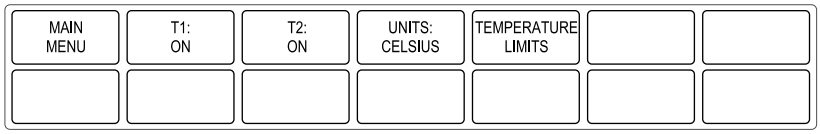
880A

Dual Temperature Cable Selection Switch

The temperature cable is plugged into the **TEMP/CO** cable connector on the module. The temperature monitoring features are found in the temperature parameter menu.

Getting to the Temperature Menu

To display the temperature menu, select the TP parameter label. The temperature menu is displayed at the bottom of the screen.



730A

Temperature Menu

- *T1* — Turns the T1 temperature site off and on.
- *T2* — Turns the T2 temperature site off and on.
- *UNITS* — Switches the units of measurement between Celsius and Fahrenheit.
- *TEMPERATURE LIMITS* — Displays a new menu and an information window to adjust alarm limits for both temperature sites.

Temperature Menu Options

T1

This direct action menu option turns monitoring off and on at temperature site 1. When off, no values are displayed in the temperature parameter window.

T2

This direct action menu option turns monitoring off and on at temperature site 2. When off, no values are displayed in the temperature parameter window.

Units

This direct action menu option switches the units of measure between Celsius (*C*) and Fahrenheit (*F*).

Temperature Limits

Select *TEMPERATURE LIMITS* to open an information window and a new menu, which allow you to adjust the following:

- Temperature site 1 (*T1*) high and low limits
- Temperature site 2 (*T2*) high and low limits

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

Troubleshooting

Messages

If you experience problems with temperature monitoring, one of the following messages may be displayed in the temperature parameter window.

CAL CHECK

There is a 0.1º C deviation between the temperature value and the internal calibration. No temperature value is displayed. Service on the module is required.

CAL FAIL

There is a 1º C deviation between the temperature value sensed and the internal calibration. No temperature value is displayed. Service on the module is required.

SENSOR

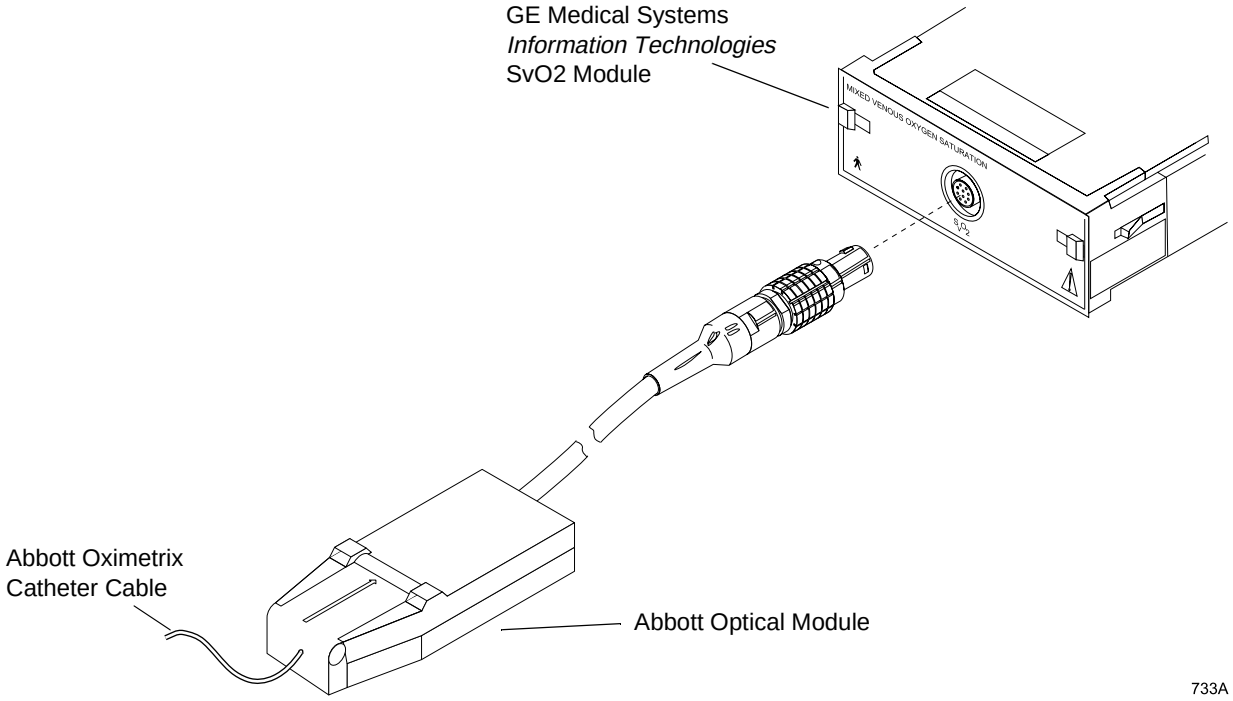
No sensor is detected. Either no sensor is present or a sensor has failed. If no sensor is present, turn the temperature site OFF to clear the message.

18 SvO2

For your notes

Introduction

Mixed venous oxygen saturation (SvO2) monitoring is done with the GE Medical Systems *Information Technologies* Mixed Venous Oxygen Saturation (SvO2) module. The module is used in conjunction with Abbott's Oximetrix catheter and Optical module to provide mixed venous oxygen saturation values.



GE Medical Systems *Information Technologies* SvO2 Module and Abbott Optical Module

NOTE

The signal input is isolated, but it is not defibrillator-proof

( ).

NOTE

The software shows SvO2 as *SVO2*. References in this manual are shown as SVO2 or SvO2.

A type of multilumen, flow-directed, pulmonary arterial catheter connects to the Abbott Optical module, which in turn connects to the GE Medical Systems *Information Technologies* SvO2 module. The catheter contains fiberoptic strands that pass three wavelengths of light directly into the blood in the pulmonary artery and transmit the reflected light back. The measurement of oxygen saturation follows the same principle as noninvasive pulse oximetry (SpO2) measurement.

SvO2 measures the percentage of hemoglobin carrying oxygen in the venous blood. When blood passes through the lungs, oxygen combines with almost all hemoglobin molecules, resulting in a saturation of approximately 100% in a normal person. When the blood passes through the tissues, a fraction of the hemoglobin molecules release their oxygen to meet the metabolic needs of the cells. The normal percentage of hemoglobin retaining oxygen in venous blood is 60-80%. This value varies with cardiac output, oxygen consumption of the tissues, the amount of normally functioning hemoglobin, and tissue oxygen consumption.

Checklist

1. The SvO2 module is securely inserted in the Tram-rac housing.
2. The Abbott optical module's cable is connected to the GE Medical Systems *Information Technologies* SvO2 module.
3. The Abbott Oximetrix catheter is connected to the Abbott optical module.
4. A preinsertion calibration procedure is done before the catheter is inserted in the patient. Refer to details in this chapter.
5. The Abbott catheter is inserted in the patient. Follow all guidelines specified in the Abbott literature.
6. Any other necessary calibration procedures are done. Refer to details in this chapter.

Signal and Data Validity

Signal Strength Indicator

It is important to determine that the signal coming from the Abbott catheter is adequate for reliable saturation readings. To make this determination, the monitor displays a signal strength indicator.

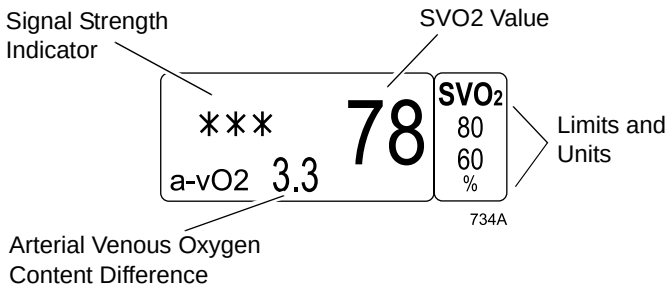
The signal strength indicator is displayed in the SVO2 values window and next to each calibration event in the SVO2 calibration history information window. This indicator consists of one, two, or three asterisks, or three dashes. The clinical implications of this indicator are:

- Three asterisks condition — Optimum light intensity.
- Two asterisks condition — Adequate light intensity for reliable saturation value.
- One asterisk condition — Inadequate light intensity for a reliable saturation value. A saturation value is displayed under these conditions, but it may not be reliable. The clinician should exercise caution and rectify the light intensity problem as soon as possible.
- Three dashes condition — Inadequate light for any calculation.

SVO2 Monitoring Features

SVO2 Information

When all connections are properly made, SVO2 information is displayed in the SVO2 parameter window on the right side (or bottom) of the screen.



SVO2 Parameter Window

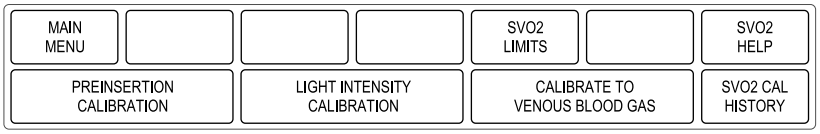
The parameter window displays the SvO2 value and a signal strength indicator. SVO2 limits and units of measure may also be displayed. An arterial venous oxygen content difference (*a-vO2*) is displayed if SPO2 is also being monitored and a hemoglobin value has been entered in pulmonary calculations.

The parameter window has an area defined for two lines of message information; however, this message area is the same area as the a-vO2 value area. Therefore, whenever a message is displayed, the a-vO2 value is not displayed.

The parameter menu is used for calibration and setting limits. There is also on-screen troubleshooting information for light intensity problems.

Getting to the SVO2 Menu

To display the SVO2 menu, select the *SVO2* parameter label. The SVO2 menu is displayed at the bottom of the screen.



SVO2 Menu

- *SVO2 LIMITS* — Displays a new menu and an information window to adjust SvO2 alarm limits.
- *SVO2 HELP* — Displays on-screen troubleshooting tips.
- *PREINSERTION CALBRATION* — Calibrate before the Abbott catheter is placed in the patient.
- *LIGHT INTENSITY CALBRATION* — Calibrate for the relative intensity of light from the Abbott catheter.
- *CALIBRATE TO VENOUS BLOOD GAS* — Calibrate the SVO2 value against a laboratory venous blood gas determination after catheter is in the patient.
- *SVO2 CAL HISTORY* — Displays a chronological history of calibrations.

SVO2 Menu Options

SVO2 Limits

Select *SVO2 LIMITS* to open an information window and a new menu, which allow you to adjust the high and low alarm limits for SVO2.

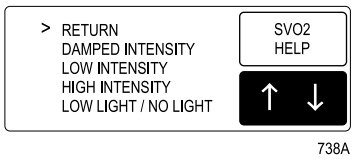
Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

SVO2 Help

To view troubleshooting tips when SvO2 alarm messages are displayed, select the *SVO2 HELP* option from the SVO2 menu. A popup menu opens, displaying the messages for which there are troubleshooting tips.

NOTE

These are the alarm messages associated with the one asterisk and three dashes signal indicators.



SVO2 Help Popup Menu

Select a message. An information window is displayed, providing information for corrective action. When you are finished, select *RETURN* to close the information window and popup menu.

Preinsertion Calibration

Refer to the Calibration section in this chapter for information about this option.

Light Intensity Calibration

Refer to the Calibration section in this chapter for information about this option.

Calibrate to Venous Blood Gas

Refer to the Calibration section in this chapter for information about this option.

SVO2 Cal History

Refer to the Calibration section in this chapter for information about this option.

Calibration

There are three different calibration procedures: *PREINSERTION CALIBRATION*, *LIGHT INTENSITY CALIBRATION*, and *CALIBRATE TO VENOUS BLOOD GAS*.

Before valid data can be obtained, either the blood gas calibration or the preinsertion calibration must be performed. If you do the preinsertion calibration, you must also do the light intensity calibration once the catheter is properly positioned in the patient. You do not need to do the light intensity calibration if you perform a venous blood gas calibration. It is done automatically.

Preinsertion Calibration

The SVO2 module has been programmed for use with a standard optical reference that is packaged with the catheter. To insure proper operation of the system, each new catheter/optical module should be calibrated to this reference before placing the catheter in the patient. After the preinsertion calibration procedure described here is completed, the system will be ready to use. If the catheter is placed in a patient without calibrating the system, a venous blood gas calibration must be performed.

To perform a preinsertion calibration, follow this procedure:

1. Connect all cables but leave the patient end of the catheter in the package.
2. ***With the catheter still in the package,*** select the *PREINSERTION CALIBRATION* option from the SVO2 menu. A popup menu opens, showing *YES, CATHETER IN PACKAGE* and *NO, CATHETER IN PATIENT* choices.
3. Select *NO, CATHETER IN PATIENT* if you do not want to do the preinsertion calibration. The popup menu will close.

   Select *YES, CATHETER IN PACKAGE* if you wish to proceed with the calibration. If the optical module has been plugged in within the last minute, the message *"WARMING UP"* may appear in the SVO2 parameter window. Wait for one minute, then select the *PREINSERTION CALIBRATION* option again and repeat the yes selection.

Once the preinsertion calibration has started, the message *"CAL TAKES UP TO 60 SECONDS"* is displayed. The length of the preinsertion calibration is dependent on the quality of the signal being received.

4. When the preinsertion calibration is complete, one of two messages is displayed:

   - *DO LIGHT CALIBRATION* — The preinsertion calibration was successful; proceed to the light intensity calibration.

     NOTE

     After a preinsertion calibration, there are no light intensity alarms until a light intensity calibration has been performed.

   - *PREINSERT CAL FAIL* — The calibration was unsuccessful. Verify that the catheter has been properly connected to the optical module and repeat the preinsertion calibration procedure. If the failure message still appears, use another catheter. Continued failure may indicate that the Abbott optical module is defective.

Light Intensity Calibration

The light intensity calibration calibrates the SvO2 module to the light intensity signal being received from the patient. A light intensity calibration must be performed after proper positioning is achieved following catheter insertion. (The catheter should be positioned such that all three asterisks appear in the SVO2 parameter window.) In addition, if any significant change in light intensity occurs that cannot be corrected (such as might happen with damage to the catheter fiberoptics), a light intensity calibration is necessary.

To perform a light intensity calibration, simply select the *LIGHT INTENSITY CALIBRATION* option from the SVO2 menu. This is a direct action menu option. The calibration takes place immediately.

NOTE

A light intensity calibration occurs automatically when a venous blood gas calibration is performed. Refer to the Calibrate to Venous Blood Gas section in this chapter.

Once the light intensity calibration has been performed, all light intensity signals are compared to the stored signal. If the detected light intensity signal becomes significantly different from the stored value, an alarm occurs and one of the following messages is displayed in the SVO2 parameter window: *DAMPED INTENSITY, HIGH INTENSITY, LOW INTENSITY.*

NOTE

There are no light intensity alarms until a light intensity calibration is performed.

Calibrate to Venous Blood Gas

Calibrate to venous blood gas for the following conditions:

- Catheter is placed in a patient without performing the preinsertion calibration procedure.
- Catheter has been disconnected from the optical module for an extended period of time, and then reconnected.
- Catheter has been in place for an extended period of time.
- Fiberoptics have been damaged.
- There is reason to suspect that the SvO2 value is incorrect.

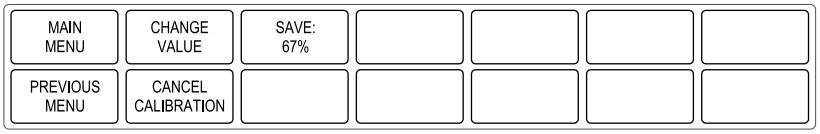
If a venous blood gas calibration is performed, it should be done when the patient's oxygen saturation is relatively stable and the light intensity signal is within normal limits (three asterisks displayed in the SvO2 parameter window).

NOTE

To achieve the accuracy ascribed to the SvO2 module, calibration to blood gas should be done using measured oxyhemoglobin saturation values, not calculated values. Oxyhemoglobin saturation values that have been calculated on the basis of measurements of PO2, pH, and temperature have been shown to be inaccurate.

Follow this procedure:

1. Select the *CALIBRATE TO VENOUS BLOOD GAS* option from the SVO2 menu. A new set of menu options is displayed.



Calibrate to Venous Blood Gas Menu

If light intensity levels are insufficient, the message "*BLOOD GAS CAL FAIL*" is displayed in the SVO2 parameter window. This message is also displayed if the optical module is not warmed up. Wait one minute, then select the *CALIBRATE TO VENOUS BLOOD GAS* option again.

NOTE

If failure continues, call Abbott service. It is likely that there is a hardware failure in the optical module.

The message "*DRAW BLOOD*" is displayed in the SVO2 parameter window for 10 seconds. Then the message "*WAITING FOR BLOOD GAS*" is displayed. Also at this time, the SvO2 module stores the preceding 5 seconds of oxygen saturation data and automatically performs the light intensity calibration.

2. If you wish to cancel the blood gas calibration, select the *CANCEL CALIBRATION* option. Monitoring continues, using the previously stored saturation value.
3. Once the laboratory analysis is complete, the results can be compared to the stored saturation value as displayed on the *SAVE* option. If the laboratory value is within four saturation units of the stored value, select *SAVE*. If the laboratory value differs from the stored value by more than four saturation units, select the *CHANGE VALUE* option and enter the laboratory value. Then select the *SAVE* option.

When the "*WAITING FOR BLOOD GAS*" message is displayed, it is possible to leave the menu by selecting *MAIN MENU* or *PREVIOUS MENU*. The "*WAITING FOR BLOOD GAS*" message continues to be displayed. To enter the saturation value once the laboratory analysis is complete, or to cancel the blood gas calibration, simply select the *CALIBRATE TO VENOUS BLOOD GAS* option in the SVO2 menu again. The calibration process does not restart because it is already in that mode from the previous menu entry. At this point, continue the calibration procedure beginning at step 2.

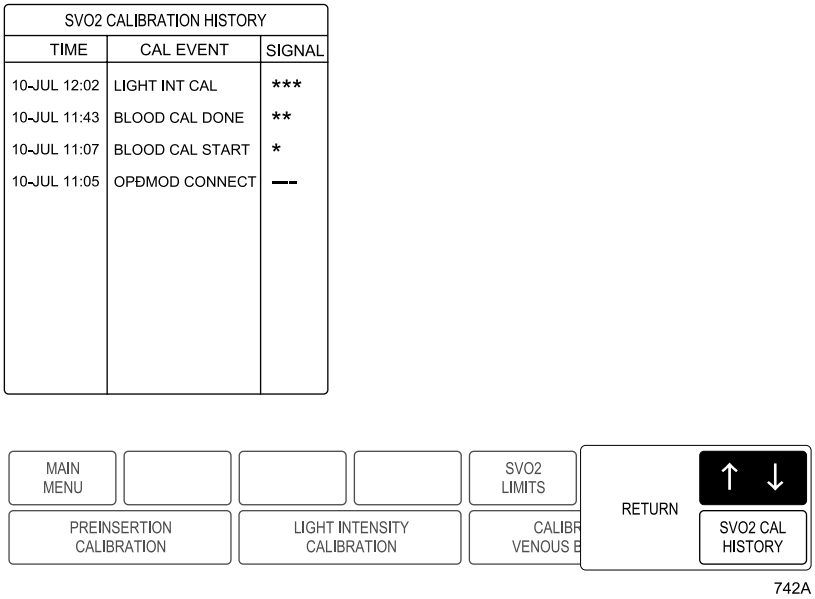
NOTE

If a light intensity condition occurs while the "*WAITING FOR BLOOD GAS*" message is displayed, the intensity condition message (for example, "*LOW LIGHT*") will be displayed alternately with the blood gas message.

SVO2 Cal History

This menu option allows you to view a chronological list of calibrations performed during monitoring. This list contains up to 10 events. After 10, the oldest event is deleted when a new event occurs.

To view the SVO2 Cal History, select *SVO2 CAL HISTORY* from the SvO2 menu. A popup menu and information window are displayed.



SVO2 Cal History Popup Menu and Information Window

You can print a copy of this calibration history by pressing the **Graph Go/Stop** button while the window is open. Press the Trim Knob control or touch the *RETURN* option to close the popup menu and information window.

These are the calibration events that are stored in the SVO2 Calibration History information window:

- *OP-MOD CONNECT* — The Abbott optical module was connected to the GE Medical Systems *Information Technologies* SvO2 module.
- *PREINS CAL DONE* — A successful preinsertion calibration was done.
- *PREINS CAL FAIL* — A preinsertion calibration failed.
- *LIGHT INT CAL* — A light intensity calibration was done.
- *BLOOD CAL START* — A calibration to venous blood gas was started.
- *BLOOD CAL DONE* — A calibration to venous blood gas was done.
- *BLOOD CAL CANCEL* — A calibration to venous blood gas was cancelled.
- *BLOOD CAL FAIL* — A calibration to venous blood gas failed.

Troubleshooting

Problem:
PREINSERT CAL FAIL message is displayed.

Solution:

- Preinsertion calibration was unsuccessful.

1. Check connections between the optical module and the SvO2 module.
2. Check connections between the optical module and the catheter.
3. Verify that the tip of the catheter is in the optical reference block.
4. Check optical module.*
5. Replace catheter.

* See below for optical module test procedure.

Problem:
LOW LIGHT or NO LIGHT message is displayed.

Solution:

- Catheter is out of package but not in the patient. Message is normal.
- Catheter is in package.

1. Check connections between the optical module and the SvO2 module.
2. Check connections between the optical module and the catheter.
3. Verify that the tip of the catheter is in the optical reference block.
4. Check optical module.*

* See below for optical module test procedure.

- Catheter is in patient.

1. Check connections between the optical module and the SvO2 module.
2. Check connections between the optical module and the catheter.
3. Manipulate the catheter to see if the message will clear.
4. Check optical module.*

* See below for optical module test procedure.

Optical Module Test Procedure:

If *LOW LIGHT* or *NO LIGHT* message fails to clear after attempting the solutions above, follow this procedure to check the optical module.

1. Disconnect catheter from optical module.
2. Close the optical module's lid and remove from direct light.
   a. If status message clears, the catheter is damaged and should be replaced.
   b. If the status message does not clear, the optical module or SvO2 module is faulty. Contact service.

Problem:
X displayed in SVO2 parameter window.

Solutions:

- Optical module has just been connected and catheter is in the package with the tip in optical reference. Perform preinsertion and light intensity calibrations.
- Optical module has just been connected and catheter is in the patient. Perform venous blood gas calibration.
- *LOW LIGHT*, *NO LIGHT*, *HIGH INTENSITY*, *LOW INTENSITY*, or *DAMPED INTENSITY* message is displayed in the parameter window. Follow directions found in the *SVO2 HELP* option in the SVO2 parameter menu.
- None of the above conditions apply or none of the solutions work. Contact service.

Problem:
SERVICE MODULE message is displayed.

Solution:

Contact service.

For your notes

19 CO2

For your notes

Introduction

End-tidal CO2 monitoring (referred to as CO2 monitoring in this manual) is a continuous, noninvasive technique for determining the concentration of CO2 (carbon dioxide) in respiratory gas by measuring the absorption of infrared light of specific wavelengths.

The light generated in the analyzer bench is passed through respiratory gas samples. The amount of absorption by CO2 in the sample is measured and digitized by the photodetector. The module processes the electronic signal and displays a waveform (labeled *CO2*) and digital values for expired CO2 (*EXP*), inspired CO2 (*INSP*), and respiratory rate (RR) on the monitor.

Depending on the module used, the monitor can accommodate both intubated and non-intubated patients.

CO2 monitoring is done with one of GE Medical Systems *Information Technologies*' CO2 modules:

- Capnostat Mainstream CO2 module — for intubated patients
- Capnostat Dual CO2 module — for either intubated or nonintubated patients
- Sidestream CO2 module — for either intubated or nonintubated patients

CAUTION
Do not attempt to use a combination of gas monitoring modules/systems (e.g., CO2, SAM, TC CO2, RAMS) at the same time. Only data from one acquisition source will be displayed.

CO2 Monitoring Features

CO2 Information

When beginning CO2 monitoring (placing a module in the Tram-rac housing and connecting the patient cable), there is a warm-up period of about two minutes. The message *"WARMING UP"* is displayed in the CO2 parameter window.

After the warm-up period, when the patient is properly connected and breath is detected, numerics are displayed in the CO2 parameter window and a CO2 waveform may be displayed on the screen.

NOTE

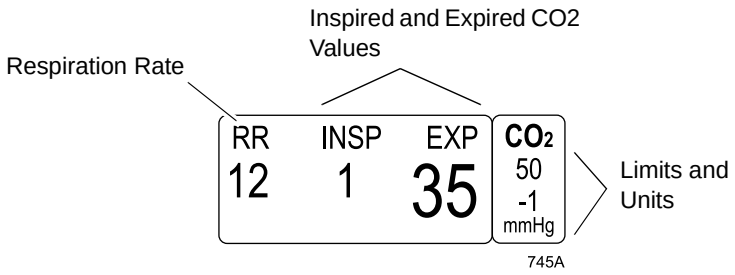
The CO2 waveform sweep speed on the screen is set at 6.25 millimeters per second, which is considerably slower than other displayed waveforms. This is done in order to show several breaths on the screen at once. You can change this speed if needed.

Capnostat modules—After the initial warming up period when a new Capnostat sensor is connected, the message *"CAL SENSOR TO ZERO CELL"* is displayed. You must zero the Capnostat sensor before monitoring can start. (Refer to the Zero Capnostat Sensor section in this chapter.)

To assure accuracy, a zero cell calibration is also required whenever any sensor is first connected to the module, whether a message is displayed or not.

CAUTION

A zero cell calibration is required each time a sensor is connected. Failure to do so can result in inaccurate CO2 values.



CO2 Parameter Window

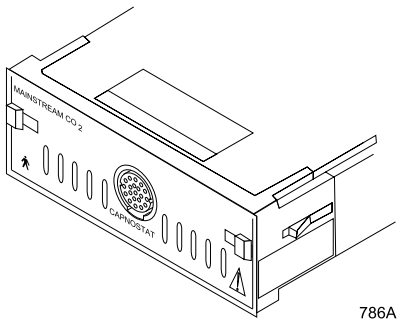
The parameter window displays the values for inspired and expired CO2 and a respiration rate. Units of measure and limits for expired CO2 may also be displayed.

The CO2 monitoring features are found in the CO2 menu. The features available depend on the CO2 module being used. All features are described in this chapter.

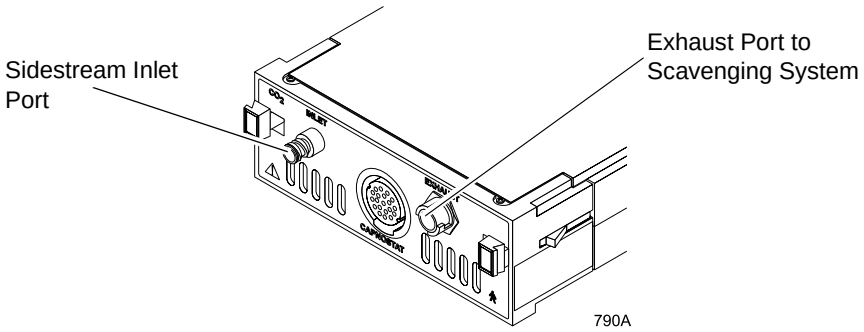
Capnostat Modules

General Information

There are two Capnostat CO2 modules, one that is strictly a mainstream module, and one that is either a mainstream or a sidestream module.



Capnostat Mainstream CO2 Module



Capnostat Dual CO2 Module

NOTE

The signal input is isolated, but it is not defibrillator-proof ( ).

CAUTIONS

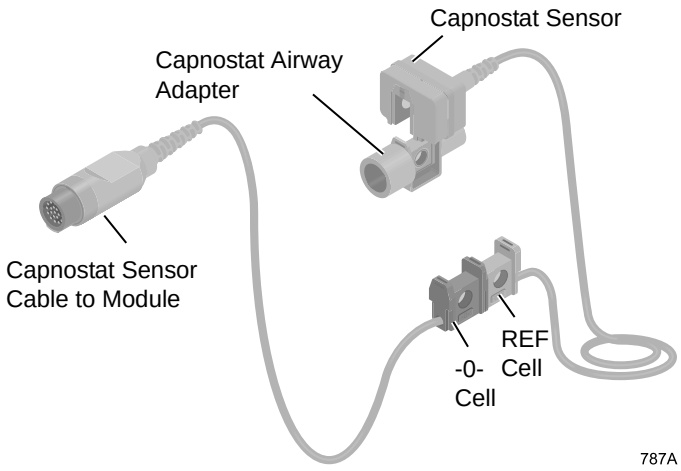
The Capnostat CO2 sensor should not be used in close proximity to wireless networking equipment or in the presence of strong electromagnetic fields such as those generated by radio station transmitters, citizens band radios, cellular phones, etc. Using the Capnostat sensor under the above conditions may cause one or all of the following to occur:

- Artifact may be induced on the capnogram.
- The CO2 parameter values may be replaced by X.
- The message "*CHECK ADAPTER*" may be displayed in the parameter window.

Normal operation will resume when the source of interference is removed.

WIRELESS LAN INTERFERENCE — Capnostat sensors with a serial number of 26104 or greater require a separation distance of 10 inches (25 cm) from the Wireless LAN adapter to minimize potential interference. Capnostat sensors with a serial number less than 26104 require a separation distance of 8.2 feet (2.5 meters) and are not recommended for use on monitoring equipment equipped with the Wireless LAN option.

The Capnostat modules must be used with a Capnostat sensor and airway adapter. There is a Capnostat airway adapter for mainstream monitoring (pictured below), and there is also a Capnostat sidestream adapter with sample tubing for sidestream monitoring. The sensor cable is equipped with two cells. The **-0-** cell is used for zeroing (calibration) of the sensor, and the **REF** cell is used for verifying sensor accuracy.



Capnostat Sensor, Cable, and Airway Adapter

Mainstream Setup

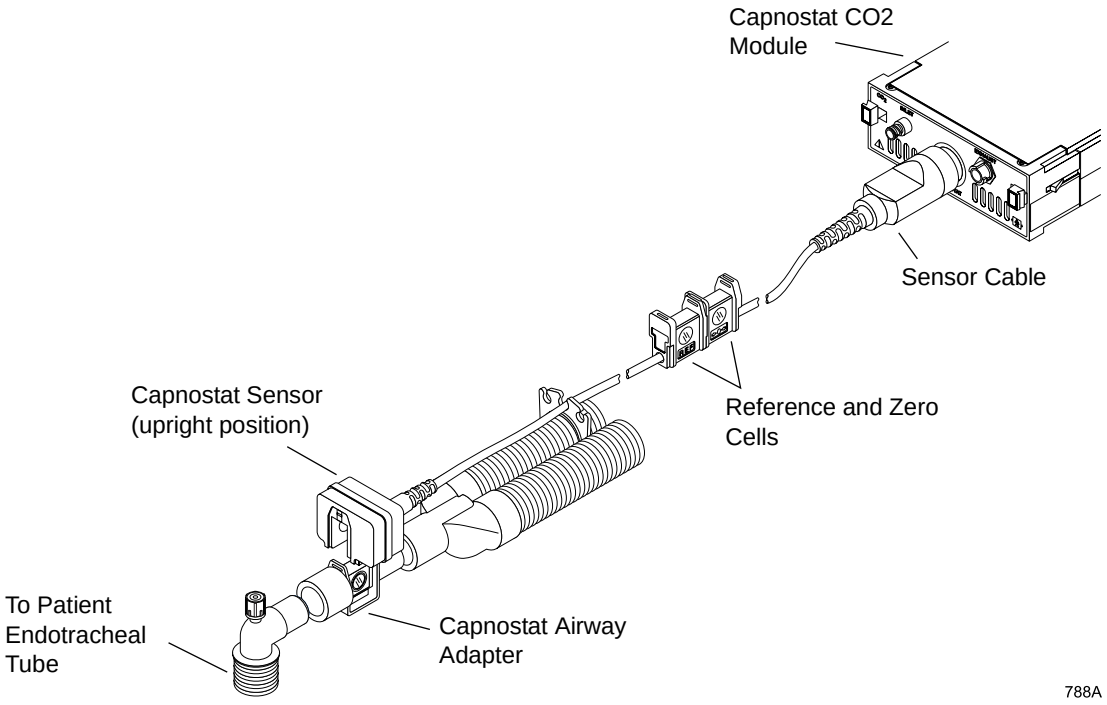
The mainstream setup is the same for both Capnostat modules.

1. Securely insert the module into the Tram-rac housing.
2. Connect the Capnostat sensor cable to the module. If the message *"CAL SENSOR TO ZERO CELL"* is displayed in the CO2 parameter window, you must zero the sensor. Refer to the Zero Capnostat Sensor section in this chapter.
3. Confirm that the monitor's barometric pressure setting is correct. (Refer to the appropriate service manual for information on how to set the barometric pressure.)
4. Snap the Capnostat airway adapter into the Capnostat sensor. If the message *"CHECK ADAPTER/ADAPTER CAL"* is displayed in the CO2 parameter window, you must calibrate the adapter. Refer to the Capnostat Adapter Calibration section in this chapter.

5. Position the adapter and sensor in the patient respiratory circuit as close to the patient as possible, between the endotracheal tube and the ventilator circuit.

NOTE

Always position the sensor with the adapter in an upright position to avoid collection of fluids on the windows of the adapter. Large concentrations of fluids at this point will obstruct gas analysis.



Mainstream Setup

Sidestream Setup (Dual Module)

CAUTION
The Capnostat dual CO2 module's sidestream withdrawal rate is 180 milliliters per minute (nominal). Do not use this module on any patient who may be affected by this withdrawal rate.

1. Securely insert the module into the Tram-rac housing.
2. Connect the Capnostat sensor cable to the module. If the message *"CAL SENSOR TO ZERO CELL"* is displayed in the CO2 parameter window, you must zero the sensor. Refer to the Zero Capnostat Sensor section in this chapter.
3. Confirm that the monitor's barometric pressure setting is correct. (Refer to the appropriate service manual for information on how to set the barometric pressure.)
4. Connect the sidestream adapter tubing to the inlet connector on the module.
5. When delivering anesthetics, connect the scavenging tube to **EXHAUST** connector on the module. Refer to the Gas Exhaust section in this chapter.
6. Attach the 5-inch adapter tubing (male-to-male) connector to the airway adapter.
7. Secure the Aqua-Knot water trap to the 5-inch adapter tubing.

   NOTE
   The Aqua-Knot water trap must be used. The arrow on the water trap shows the direction of the gas flow. When inserting the water trap, the arrow should point toward the module.

8. Connect the nasal cannula or sample line to the Aqua-Knot water trap.
9. Turn the pump on by selecting the *PUMP* menu option in the CO2 menu.

10. Snap the Capnostat sidestream adapter with its tubing into the Capnostat sensor. If the message *"CHECK ADAPTER/ADAPTER CAL"* is displayed in the CO2 parameter window, you need to calibrate the adapter. (Refer to this chapter, Capnostat Adapter Calibration.)

    NOTE

    Always position the sensor with adapter in an upright position to avoid collection of fluids on the windows of the adapter. Large concentrations of fluids at this point will obstruct gas analysis.

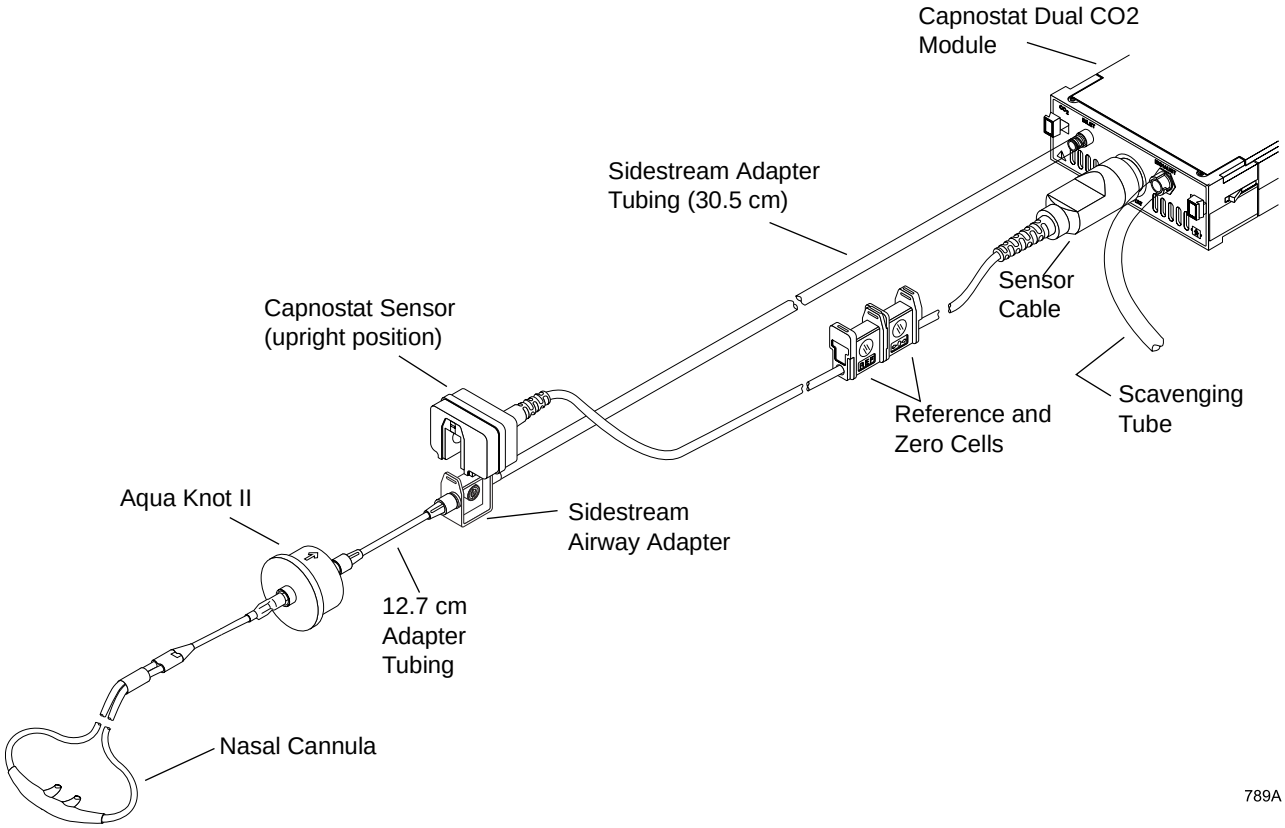
11. Occlude the open end of the airway circuit. The message "*BLOCKED LINE*" must appear in the CO2 parameter window to ensure that a blockage will be recognized during patient monitoring.

    CAUTION

    The sidestream analyzer will not detect a leak in the breathing circuit. A leak in the breathing circuit may cause inaccurate readings.

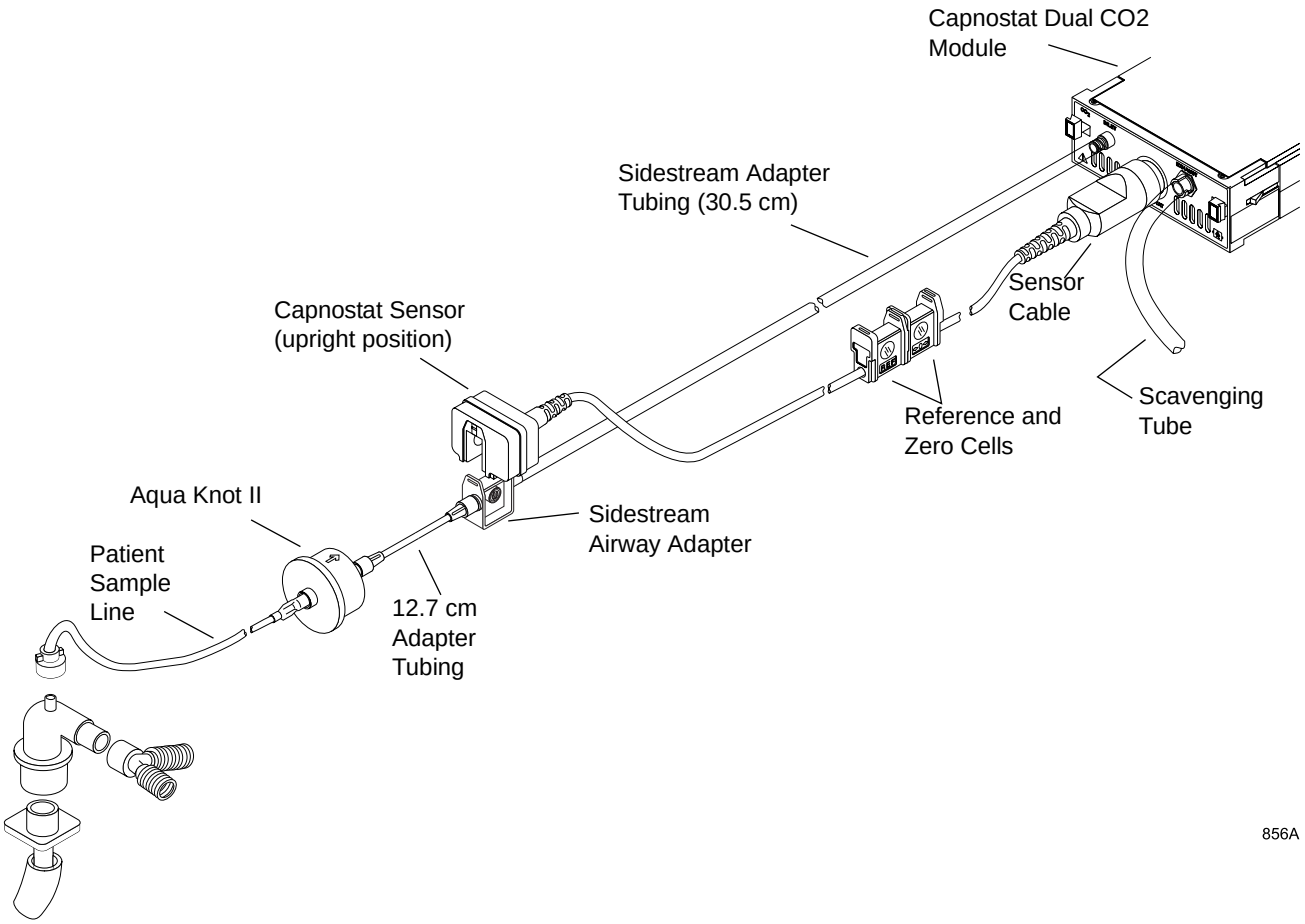
12. Position the nasal cannula on the patient according to the manufacturer's instructions or attach the patient sample line to the patient airway adapter.

Non-Intubated Patients



Sidestream Setup for Non-Intubated Patients

Intubated Patients



Sidestream Setup for Intubated Patients

Gas Exhaust

When using the sidestream method for monitoring CO2 and anesthetics are being delivered, the gas exhaust must be considered. The gas exhaust may be scavenged using the scavenging adapter package (pn 9504-016). Follow the steps below to properly connect the module to an anesthesia machine exhaust circuit.

CAUTIONS

EXHAUST LINE — Do not allow the exhaust line to become kinked or blocked. Back pressure may cause inaccurate gas readings and also may cause serious damage to the module's internal components.

INFECTIOUS DISEASE — To avoid the spread of infectious disease, do not allow the exhaust to discharge in the direction of the patient or user.

VACUUM SOURCE — Do NOT connect exhaust of the module to an unregulated, high vacuum source. Pressure may cause inaccurate gas readings and also may cause serious damage to the equipment's internal components.

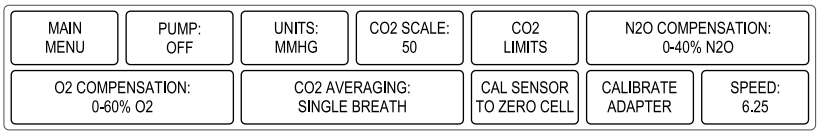
1. Remove exhaust adapter and tube from the package.
2. Attach the connector end of the exhaust tube to the outlet marked **EXHAUST** on the front of the module.
3. Install the exhaust adapter into the gas scavenging system of the anesthesia delivery system, following the anesthesia machine manufacturer's recommended procedure.
4. Drape the exhaust tube so that it does not obstruct the work area.

CO2 Menu Options (Capnostat Modules)

Getting to the CO2 Menu

The menu options for both Capnostat modules are identical, with the exception of the Pump option.

To display a CO2 menu, select the *CO2* parameter label. The CO2 menu is displayed at the bottom of the screen.



Capnostat CO2 Menu

- *PUMP* — Turns the module's pump on (or off) when using the sidestream setup (Capnostat dual CO2 module only).
- *UNITS* — Changes the units of measure for inspired and expired CO2.
- *CO2 SCALE* — Selects a scale for the displayed CO2 capnogram.
- *CO2 LIMITS* — Displays a new menu and information window to adjust expired CO2, inspired CO2, respiration rate, and no breath limits.
- *N2O COMPENSATION* — Compensates for the effect of N2O on CO2 readings. (Functional in Operating Room mode only.)
- *O2 COMPENSATION* — Compensates for the effect of O2 on CO2 readings.
- *CO2 AVERAGING* — Opens a popup menu to select a time for averaging CO2.
- *CAL SENSOR TO ZERO CELL* — Opens a popup menu to zero the sensor.
- *CALIBRATE ADAPTER* — Opens a popup menu to calibrate the airway adapter.
- *SPEED* — Changes the sweep speed of the displayed CO2 waveform.

Detailed information on each option is found in this chapter.

Pump

NOTE

The Pump option only appears in the menu when using the Capnostat dual module.

Use the *PUMP* menu option to turn the module's pump on and off. The pump must be on when using the sidestream method. This is a direct action menu option that switches between on and off.

A blocked line condition may cause the pump to shut off automatically. To restart the pump, clear or replace any blocked lines and select the *PUMP* option from the CO2 menu. (Refer to the *BLOCKED LINE* message in the Troubleshooting section of this chapter.)

Units

This option is used to select the units of measure for expired and inspired CO2. Select the *UNITS* option from the CO2 menu. A popup menu opens, showing the options *MMHG*, *%*, and *kPa*.

Select the desired units of measure. The popup menu closes, and the menu option now indicates the units selected. The units are also displayed in the limits parameter window.

NOTE

Respiration is always measured in breaths per minute, and No Breath is always measured in seconds.

CO2 Scale

This option is used to select an appropriate scale for the displayed CO2 waveform. The scale choices vary, depending on the units of measure being used.

A waveform that exceeds the allowed display area on the screen will be flattened on top. Adjust the scale to reduce the waveform size. Selecting a large scale value reduces the size of the waveform. Conversely, a smaller scale value increases the size of the waveform.

To change the scale, select the *SCALE* option from the CO2 menu. A popup menu opens, displaying the available options. Select the desired option. The popup menu closes, and the menu option now indicates the scale of your choice. The scale lines on the screen also reflect the new scale.

CO2 Limits

Select *CO2 LIMITS* to open an information window and a new menu, which allow you to adjust the following:

- Expired (*EXP*) high and low limits
- Inspired (*INSP*) high limit
- Respiration (*RESP*) high and low limits
- No breath limit

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

N2O Compensation

NOTE
This feature functions only when the monitor is in the Operating Room mode.

The presence of nitrous oxide causes the CO2 value to appear higher than the actual value. Use this option to compensate for the presence of N2O.

This is a direct action menu option that switches between *0-40% N2O* and *>40% N2O*. Your selection depends on the amount of N2O present.

The *0-40% N2O* range does not require compensation. When *>40% N2O* is chosen, compensation is calculated using the following formula:

Displayed CO2 = Measured CO2 x 0.974

The correction is applied to the displayed values of end-tidal CO2 and inspired CO2. The waveform is also adjusted.

NOTE
N2O concentration can be obtained from the anesthesia machine.

O2 Compensation

The presence of a large concentration of oxygen causes the CO2 value to appear lower than the actual value. Use this option to compensate for the presence of O2.

This is a direct action menu option that switches between *0-60% O2* and *>60% O2*. Your selection depends on the amount of O2 present.

NOTE
O2 concentration can be obtained from the anesthesia machine.

CO2 Averaging

Select this menu option to open a popup menu to select a time interval for averaging CO2:

- *SINGLE BREATH* — A CO2 value is calculated for every breath.
- *10 SECONDS* — A CO2 value is calculated using 10 seconds of data.
- *20 SECONDS* — A CO2 value is calculated using 20 seconds of data.

Cal Sensor to Zero Cell

Use this menu option to zero the Capnostat sensor. This is required whenever a new sensor is connected to the monitor. Refer to the Zero Capnostat Sensor section in this chapter.

Calibrate Adapter

Use this menu option to calibrate the Capnostat airway adapter. Refer to the Calibrate the Capnostat Adapter section in this chapter.

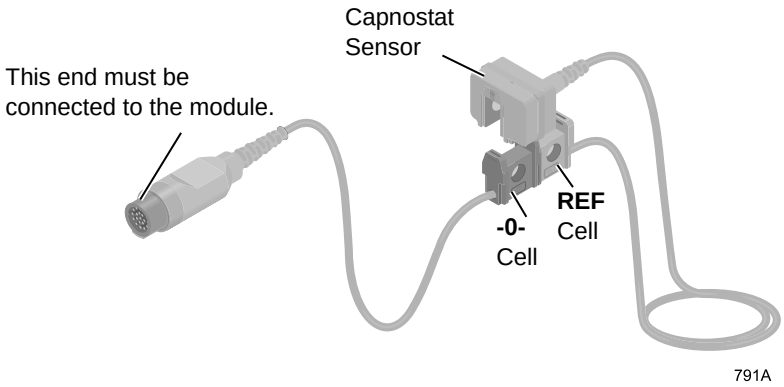
Speed

Use this menu option to open a popup menu to select a sweep speed for the displayed CO2 waveform. Choices are 6.25 (default), 12.5, 25, and 50 millimeters per second.

Zero the Capnostat Sensor

A sensor must be zeroed (calibrated) whenever it is connected to a Capnostat module, and whenever *"CAL SENSOR TO ZERO CELL"* or *"NOT CALIBRATED"* is displayed.

The sensor cable has two cells, as shown in the figure below. One is marked "**-0-**" (zero), and the other is marked "**REF**" (reference).



Zeroing the Sensor

To zero the sensor:

1. Remove the adapter from the sensor, but be certain that the sensor cable is still connected to the module.
2. Ensure that the cell windows are clean and dry. (Refer to the Capnostat Sensor and Adapter Cleaning section in this chapter.)
3. Place the sensor on the cell marked "**-0-**." (See the figure above.)
4. Select the **CAL SENSOR TO ZERO CELL** option from the CO2 menu. A popup menu opens with the options *READY* and *ABORT*.
5. Select *READY*. The message *"CALIBRATING"* is displayed in the CO2 parameter window. When calibration is complete, the popup menu clears and an *EXP* value of *0* is displayed in place of the message.
6. Remove the sensor from the **-0-** cell and place it on the **REF** cell. An *EXP* value of 38 mmHg (± 2 mmHg) is displayed. If the value is not within this range, the sensor is out of tolerance and should be replaced. For cleaning maintenance, refer to the Capnostat Sensor and Adapter Cleaning section in this chapter.

Calibrate the Capnostat Adapter

An adapter calibration is required under the following conditions:

- Whenever you change adapter types, for example, adult to low volume dead space, or mainstream to sidestream.
- When the monitor displays the message "*CHECK ADAPTER / ADAPTER CAL.*"

Before calibrating, be sure the airway adapter is clean and clear of foreign matter.

NOTE

Prior to calibrating the Capnostat sidestream adapter, all sampling tubing must be attached and the pump must be turned on.

Follow this procedure to calibrate the adapter:

1. Place the sensor and the adapter away from all sources of CO2, including the patient's and your own exhaled breath, and ventilator exhaust valves.
2. With the adapter connected to the sensor and the sensor connected to the monitor (and, when used, all sidestream tubing attached and the pump turned on), select the *CALIBRATE ADAPTER* option from the CO2 menu. A popup menu opens, showing the options *READY* and *ABORT*.
3. Select *READY*. The message "*CALIBRATING*" is displayed in the CO2 parameter window. When calibration is complete, the popup menu closes and the message clears.

Capnostat Sensor and Adapter Cleaning

Cleaning the Capnostat Sensor

- Clean the sensor surface with a damp cloth.
- Ensure that the sensor windows are clean and dry.
- Do NOT immerse the sensor.
- Do NOT attempt to sterilize the sensor.

Cleaning the Reusable Capnostat Adapters

- An adapter can be cleaned by rinsing it in a warm soapy solution followed by soaking it in a liquid disinfectant, by pasteurizing it, or cold sterilizing (glutaraldehyde) it. It should then be rinsed with sterile water and dried.

  NOTE

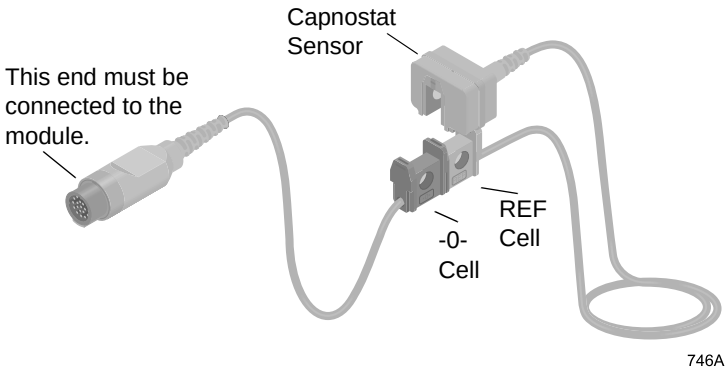
  The sidestream adapter should only be cold cleaned. The interior of the tubing can be dried by flushing with air or oxygen.

- The adult and low volume dead space adapters may be sterilized using the ETO (ethylene oxide) gas method. They may also be sterilized using a steam autoclave method, but lifetime could be affected.
- Before reusing any adapter, ensure that the windows are dry and residue-free, and that the adapter has NOT been damaged during handling or by the cleaning/sterilization process.

Capnostat Sensor Troubleshooting

Capnostat Sensor Check

The sensor cable has two cells, as shown in the figure below. One is marked "**-0-**" (zero), and one is marked "**REF**" (reference). Whenever you suspect incorrect values or sensor failure, perform a sensor check.



Sensor Check and Calibration Cells

Follow these steps to perform a sensor check:

1. Remove the adapter from the sensor, but be certain that the sensor cable is still connected to the module.
2. Ensure that the cell windows are clean and dry. Refer to the Capnostat Sensor and Adapter Cleaning section in this chapter.
3. Place the sensor on the cell marked "**REF**." Depending on the units of measure, you should see a reading of 38 mmHg (± 2) on the display. If the displayed value is within range, you can resume monitoring. If the sensor is not within range, the error message "*NOT CALIBRATED*" is displayed. You must calibrate the sensor to the zero cell. Refer to the Zero Capnostat Sensor section in this chapter.

WARNING

The end-tidal CO2 value ($ETCO_2$) is in most cases considerably lower than the CO2 partial pressure determined by blood-gas analysis. The major clinical reasons are:

- dead-space ventilation, ventilation/perfusion mismatch
- drop in cardiac output
- alveolar shunts
- incomplete emptying of the alveoli

TECHNICAL REASONS (MUST BE CORRECTED):

- leak in the respiration tube system
- hypothermia, but blood-gas analysis at 37º C
- anesthesia gases (correction possible for O2 and N2O only)

Messages

Following is a list of some of the messages that may appear on the monitor when monitoring CO2. The message should clear when normal operating criteria are met or a solution is found. If a message persists, call GE Medical Systems *Information Technologies* for service at 1-800-558-7044 (U.S. only). Outside the United States, please contact your sales/service office.

NOTE

The actual message that appears on your monitor depends on the module being used and the installed software version.

BLOCKED LINE

Cause:	Nasal cannula, moisture filter, sidestream adapter tube, or exhaust line is blocked.
Solution:	Check nasal cannula, moisture filter, sidestream adapter tube, and exhaust lines for blockage and replace if necessary. If the blocked line condition persists for a period of time, the monitor's pump will automatically shut off. The pump must then be restarted to clear the message. To restart the pump, select the *PUMP* option from the CO2 menu. Repeat this process until the *BLOCKED LINE* message clears.

CABLE DISCONNECTED

Cause:	Sensor cable is not connected to module.
Solution:	Check sensor cable connection.

CAL SENSOR TO ZERO CELL

Cause:	A new sensor was introduced into the system or there is a possible signal drift in sensor electronics.
Solution:	Zero the CO2 sensor. (Refer to the Zero Capnostat Sensor section in this chapter.)

CANNOT CALIBRATE

Cause:	Message appears when attempting calibration in an unstable condition, such as sensor still warming up or other error condition.
Solution:	Calibrate sensor when no error condition exists.

CHANGE AIRWAY ADAPTER

Cause: Sensor signal is out of tolerance.

Solution: Check for obstructions in airway adapter or other defects.

CHECK ADAPTER/ADAPTER CAL

Cause: Adapter is not attached to sensor, adapter is obstructed, or adapter used is of a different type than the one last calibrated to the sensor.

Solution:
- Check that the sensor is securely snapped onto the adapter.
- Check for possible obstructions in the adapter and clean if required.
- If message persists, calibrate adapter (refer to the Capnostat Adapter Calibration section in this chapter).

CHECK SAMPLE LINE

Cause: Sample line is disconnected or sample line used is of a different type than the type used when adapter was last calibrated.

Solution: Be sure the sample line is securely connected. If the sample line is different, recalibrate the adapter using the new type of sample line.

INCOMPATIBLE SENSOR

Cause: Capnostat sensor is of older type and not supported by module software.

Solution: Use only a Capnostat 3 sensor.

NO BREATH DETECTED

Cause: No breath detected or sensor is disconnected from patient airway.

Solution: Check the patient and all patient connections.

NOT CALIBRATED

Cause: Sensor signal is out of tolerance.

Solution: Calibrate the sensor using the Zero Capnostat Sensor instructions in this chapter.

SERVICE CO2 MODULE…

Cause: Module failure. (Type of failure is displayed in the message: *CPU, ROM, RAM, 2µP, TMP.*)

Solution: Note the specific error message and call GE Medical Systems *Information Technologies* for service, or contact your sales/service representative.

UNKNOWN ERROR

Cause: Module failure, type unknown.

Solution: Call GE Medical Systems *Information Technologies* for service or contact your sales/service representative.

WARMING UP

Cause: Appears whenever a sensor is first plugged in, a module is placed in a Tram-rac, and when a sensor is first powered on.

Solution: Message will clear when warmed up. If it persists beyond 4 minutes, call GE Medical Systems *Information Technologies* service or contact your sales/service representative.

Sidestream Modules

These modules use a different technology and are not compatible with the Capnostat sensor and adapter.

CAUTIONS

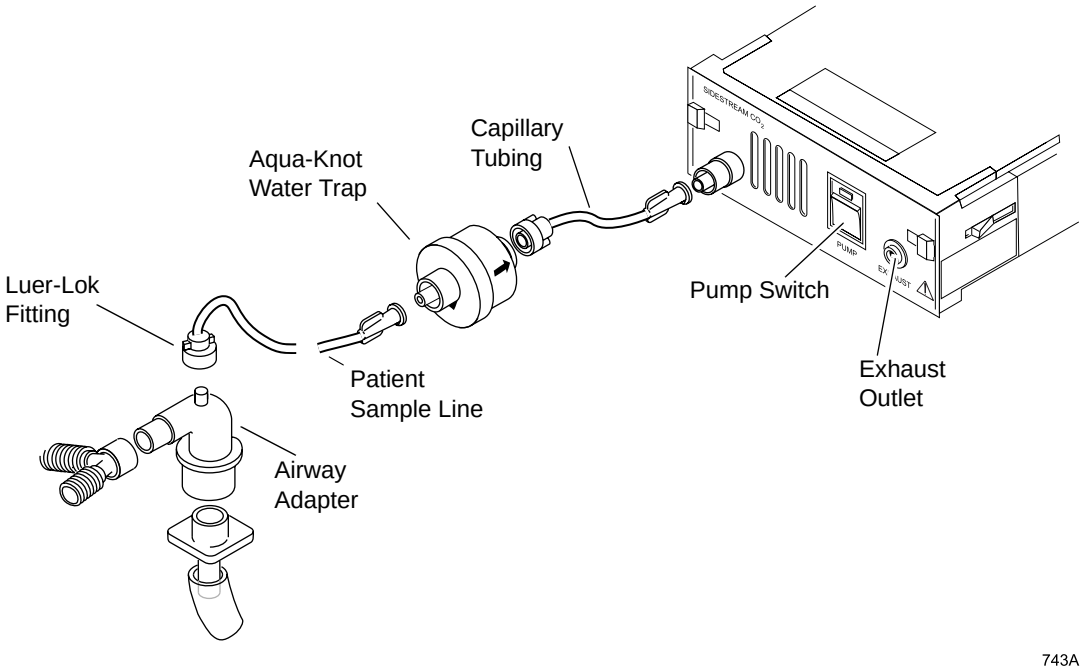
PREVENT CONTAMINATION — Be sure the pump is off before removing the Aqua-Knot water trap to prevent contamination of the internal gas measurement instruments.

WATER TRAP — An Aqua-Knot water trap must always be used when the unit is running. Failure to use the water trap can result in contamination of the internal gas measurement instruments and may cause subsequent inaccurate gas analysis data.

Replace and dispose of the Aqua-Knot water trap when occluded. Do not reuse. Reusing the water trap may cause inaccurate readings and may damage the equipment.

WITHDRAWAL RATE — The Sidestream CO2 module continuously withdraws 200 milliliters per minute from the patient airway. Do not use this module on any patient who may be affected by this withdrawal rate.

Sidestream Module Setup



Sidestream Module Setup

The airway adapter is placed between the endotracheal tube and the breathing circuit to the ventilator or humidified oxygen source. A pump in the module draws the gas from a Luer-lok fitting located on the airway adapter, through a long tube, through the Aqua-Knot water trap, through the capillary sample tubing, and into the module. Analysis takes place inside the module.

NOTE

For non-intubated patients, the sidestream module can be used with a CO2 sampling nasal cannula.

NOTE

Always position the Luer-Lok connection and patient sample line in an upright position to avoid aspiration of fluids into the patient sample line, which will cause premature blockage.

NOTE

Delivery of bronchodilators or mucolytics via aerosol and meter dose inhalers causes premature blockage of the Aqua-Knot water trap. Discontinue gas analysis prior to treatment by switching the pump off and removing the airway adapter from the ventilator circuit, or disconnecting the sample line from the Aqua-Knot water trap.

Pump Control

To turn the pump on and off (standby mode), press and release the pump switch located on the front of the module. The green light just above the switch is illuminated when the pump is on.

NOTE

With module software version 3 and subsequent, the pump will automatically turn off after 20 minutes of no CO2 detection.

Gas Exhaust

The gas exhaust may be scavenged using the scavenging adapter package (pn 9504-016) included with each Sidestream CO2 module. Follow the steps below to properly connect the module to an anesthesia machine exhaust circuit.

CAUTIONS

EXHAUST LINE — Do not allow the exhaust line to become kinked or blocked. Back pressure may cause inaccurate gas readings and also may cause serious damage to the module's internal components.

INFECTIOUS DISEASE — To avoid the spread of infectious disease, do not allow the exhaust to discharge in the direction of the patient or user.

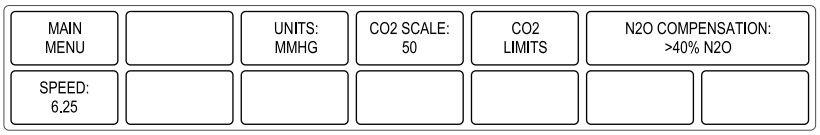
VACUUM SOURCE — Do NOT connect exhaust of the module to an unregulated, high vacuum source. Pressure may cause inaccurate gas readings and also may cause serious damage to the equipment's internal components.

1. Remove exhaust adapter and tube from the package.
2. Attach the connector end of the exhaust tube to the outlet marked **EXHAUST** on the front of the module.
3. Install the exhaust adapter into the gas scavenging system of the anesthesia delivery system, following the anesthesia machine manufacturer's recommended procedure.
4. Drape the exhaust tube so that it does not obstruct the work area.

CO2 Menu Options (Non-Capnostat Modules)

Getting to the CO2 Menu

To display a CO2 menu, select the CO2 parameter label. The CO2 menu is displayed at the bottom of the screen.



CO2 Menu

- *UNITS* — Changes the units of measure for inspired and expired CO2.
- *CO2 SCALE* — Selects a scale for the displayed CO2 capnogram.
- *CO2 LIMITS* — Displays a new menu and information window to adjust expired CO2, inspired CO2, respiration rate, and no breath limits.
- *N2O COMPENSATION* — Compensates for the effect of N2O on CO2 readings. (Functional in Operating Room mode only.)
- *SPEED* — Changes the sweep speed of the displayed CO2 waveform.

Detailed information on each option is found in this chapter.

Units

This option is used to select the units of measure for expired and inspired CO2. Select the *UNITS* option from the CO2 menu. A popup menu opens, showing the options *MMHG, %,* and *kPa*.

Select the desired units of measure. The popup menu closes, and the menu option now indicates the units selected. The units are also displayed in the limits parameter window.

NOTE

Respiration is always measured in breaths per minute, and No Breath is always measured in seconds.

CO2 Scale

This option is used to select an appropriate scale for the displayed CO2 waveform. The scale choices vary, depending on the units of measure being used.

A waveform that exceeds the allowed display area on the screen will be flattened on top. Adjust the scale to reduce the waveform size. Selecting a large scale value reduces the size of the waveform. Conversely, a smaller scale value increases the size of the waveform.

To change the scale, select the *SCALE* option from the CO2 menu. A popup menu opens, displaying the available options. Select the desired option. The popup menu closes, and the menu option now indicates the scale of your choice. The scale lines on the screen also reflect the new scale.

CO2 Limits

Select *CO2 LIMITS* to open an information window and a new menu, which allow you to adjust the following:

- Expired (*EXP*) high and low limits
- Inspired (*INSP*) high limit
- Respiration (*RESP*) high and low limits
- No breath limit

Refer to the Setting Alarm Limits section in Chapter 1, The Basics, for information about how to adjust alarm limits.

N2O Compensation

NOTE

This feature functions only when the monitor is in the Operating Room mode.

The presence of nitrous oxide causes the CO2 value to be higher than the actual value. Use this option to compensate for the presence of N2O.

This is a direct action menu option, which switches between *0-40% N2O* and *>40% N2O*. Your selection depends on the amount of N2O present.

The *0-40% N2O* range does not require compensation. When *>40% N2O* is chosen, compensation is calculated using the following formula:

Displayed CO2 = Measured CO2 x 0.974

The correction is applied to the displayed values of end-tidal CO2 and inspired CO2. The waveform is also adjusted.

NOTE

N2O concentration can be obtained from the anesthesia machine.

Speed

Use this menu option to open a popup menu to select a sweep speed for the displayed CO2 waveform. Choices are 6.25 (default), 12.5, 25, and 50 millimeters per second.

20 Interfaces

For your notes

Introduction

The monitor can interface with other manufacturers' peripheral bedside devices, such as ventilators and gas delivery systems, to centralize patient data on one device. An Octanet connectivity device is used with the monitor to communicate with peripheral devices.

IMPORTANT: The monitor can only display information that the peripheral device sends. The parameters sent vary with each peripheral device and are subject to change without notice by the manufacturer of the device.

The following chart shows the compatible peripheral devices at the time this manual was published. This table is organized by device type.

Device Connectivity Chart

Device Type	Manufacturer and Model	TIA	Octanet	Waveforms	Alarms
Anesthesia machine	**Dräger Julian**	No	Yes	Pressure, CO2	Yes
Anesthesia machine	**Dräger Cato**	No	Yes	Pressure, CO2	Yes
Anesthesia machine	**Dräger Cicero B/C**	No	Yes	None	Yes
Anesthesia machine	**Dräger Cicero EM**	No	Yes	Pressure, CO2	Yes
Anesthesia machine	**Dräger PM 8060**	No	Yes	Pressure, CO2	Yes
Anesthesia machine	**North American Dräger Narkomed 2B, 2C, 3, 4, GS, 6000**	Yes	Yes	2C/4: Pressure, Flow 4 only: CO2	Yes
Anesthesia machine	**Engström EAS 9000, 9010, 9020**	Yes	Yes	Pressure, Flow, CO2	Yes
Anesthesia machine	**MIE Kestrel**	No	Yes	None	Yes
Anesthesia machine	**Ohmeda 7800, 7810**	No	Yes	None	Yes
Anesthesia machine	**Ohmeda 7900**	No	Yes	None	Yes
Anesthesia machine	**Ohmeda Aestiva 3000**	No	Yes	None	Yes
Anesthesia machine	**Taema Alys**	No	Yes	Pressure, Flow	Yes
BIS monitor	**Aspect A-2000 BIS**	No	Yes	None	No
Continuous cardiac output	**Abbott Q-Vue**	Yes	Yes	na	Status messages only
Continuous cardiac output with SVO2	**Abbott Q-2**	Yes	Yes	na	Status messages only

Device Connectivity Chart

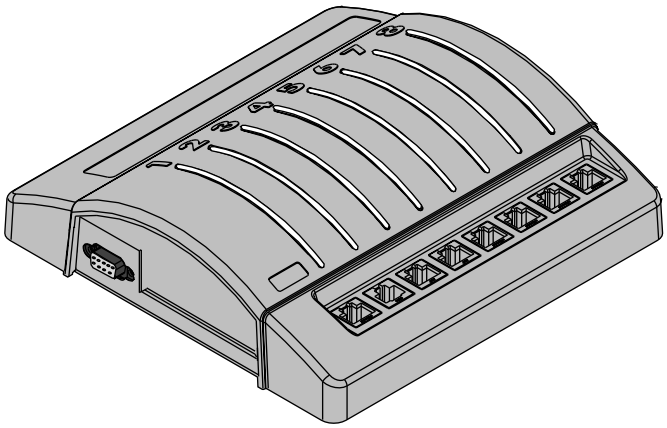
Device Type	Manufacturer and Model	TIA	Octanet	Waveforms	Alarms
Continuous cardiac output with SVO2	**Baxter Edwards Vigilance**	Yes	Yes	na	Yes
Gas analyzer	**Datex Capnomac Ultima**	Yes	Yes	CO2 (TIA only)	Yes
Gas analyzer	**Ohmeda 5250 RGM**	Yes	Yes	CO2 (TIA only)	Yes
Gas analyzer	**Ohmeda Rascal II**	Yes	Yes	CO2 (TIA only)	No
IV pump	**Abbott LifeCare 5000**	No	Yes	na	Status messages
IV pump	**Alaris Medical Systems 560M, 570**	No	Yes	na	Status messages
IV pump	**Alaris Medical Systems Gemini PC-1, PC-2, PC-2TX, PC-4**	No	Yes	na	Status messages
IV pump	**Baxter Edwards Flowgard 6201, 6301**	No	Yes	na	Status messages
NICO monitor	**Novametrix NICO**	No	Yes	Pressure, Flow Volume, CO2, SpO2	Yes
POC Testing	**Diametrics IRMA**	No	Yes	na	Yes
Pulse oximeter	**Nellcor Puritan Bennett N-200**	No	Yes	na	Yes
Transcutaneous monitor	**Novametrix 840 PtcO2/PtcCO2, TCO2M**	Yes	Yes	na	Status messages only
Transcutaneous monitor	**Radiometer TINA (TCM3)**	Yes	Yes	na	Yes
Urometer	**Bard CritiCore**	No	Yes	na	Status messages
Ventilator	**Bear 1000**	Yes	Yes	Pressure, Flow	Yes
Ventilator	**Bird 6400ST, 8400ST**	Yes	Yes	None	Yes
Ventilator (neonatal)	**Bird VIP**	Yes	Yes	None	Yes
Ventilator (neonatal)	**Dräger Babylog 8000**	Yes	Yes	Pressure, Flow	Only with TIA
Ventilator	**Dräger Evita**	Yes	Yes	Pressure	Yes
Ventilator	**Dräger Evita 2, Evita 2 Dura, Evita 4**	Yes	Yes	Pressure, CO2	Yes
Ventilator	**Hamilton Amadeus, Veolar**	Yes	Yes	Pressure, Flow	Yes
Ventilator	**Hamilton Galileo**	No	Yes	Pressure, Flow	Yes
Ventilator	**Nellcor Puritan Bennett Adult Star, Adult Star 1500, 2000**	Yes	Yes	Pressure (TIA only)	Yes

Device Connectivity Chart

Device Type	Manufacturer and Model	TIA	Octanet	Waveforms	Alarms
Ventilator (neonatal)	**Nellcor Puritan Bennett Infant Star, Infant Star 500, 950**	Yes	Yes	Pressure (TIA only)	Yes
Ventilator	**Nellcor Puritan Bennett 7200SPE, AE, E**	Yes	Yes	Pressure, Flow (TIA only)	Yes
Ventilator	**Puritan-Bennett 840**	No	Yes	None	Yes, with the following exceptions: $\dot{V}_{E\,TOT}$ $V_{TE\,MAND}$ $V_{TE\,SPONT}$ $V_{TI\,SPONT}$
Ventilator	**Siemens SV900C, 900D, 900E**	Yes	Yes	Pressure, Flow (TIA only)	Only with TIA
Ventilator (adult/ neonatal)	**Siemens SV300**	Yes	Yes	Pressure, Flow (TIA only)	Only with TIA

Octanet Connectivity Device

An Octanet connectivity device can interface with up to eight different devices for one patient.



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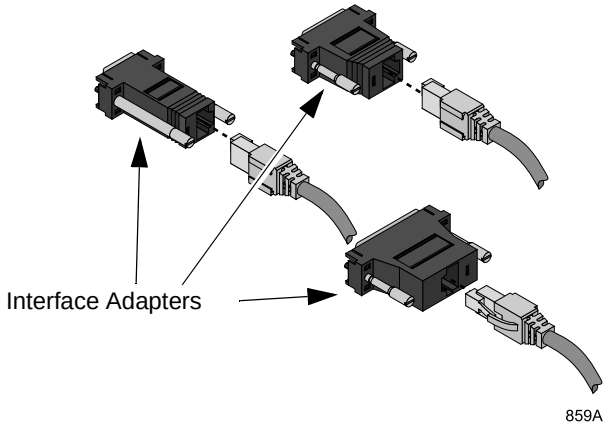
Octanet Connectivity Device

Each peripheral device connected to the Octanet connectivity device must use a special interface adapter that is factory programmed to allow communication between the two devices. Communication setup and installation instructions are provided with each interface adapter. Please refer to this information for specific instructions regarding where the interface adapter is connected to the peripheral device, as well as any special settings needed to facilitate communication with the peripheral device.



Interface Adapters

Safety

WARNINGS

ACCURACY — Patient information transferred by the Octanet connectivity device to a clinical information system must be qualified by medical personnel before permanent storage in a database.

ALARMS — The peripheral device's alarms must not be turned off or the volume reduced in any way to diminish the importance of the peripheral device as the primary alarm source for parameters monitored by the peripheral device.

CORRECT ADAPTER — Use of the wrong interface adapter may cause improper operation of the supported peripheral device. Verify that the correct interface adapter on the peripheral device is operational before the device is used on a patient.

WARNINGS

INSTALLATION — Qualified technical personnel must connect the interface adapter to the peripheral device and make any necessary adjustments to the peripheral device (baud rate, parity, etc.) as described in the specific installation instructions for the interface adapter.

Insert cabling from the Octanet connectivity device only into specified interface adapters and specified peripheral devices.

To avoid inadvertent disconnection, route all cables in a way to prevent a stumbling hazard. Wrap and secure excess cabling to reduce risk of entanglement by patients and personnel. Do not install in a location where the device may drop on a person.

SINGLE PATIENT USE — All eight serial ports of the Octanet device must only be used by one patient.

CAUTION

INSTALLATION — To avoid accidental ingress of liquids, always mount the Octanet connectivity device in a vertical position with the connectors at the bottom.

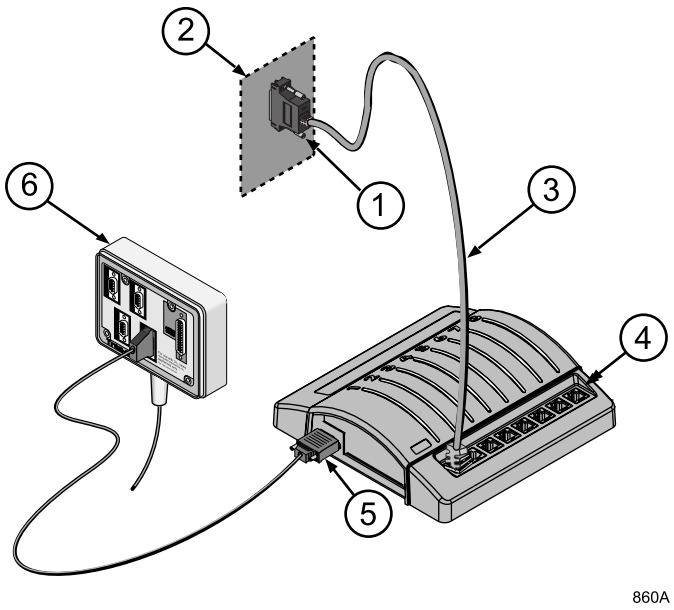
NOTE

To assure proper operation, we recommend that you permanently connect each interface adapter to each peripheral device that will communicate with the Octanet connectivity device.

Interconnection

Before connecting, refer to the instructions provided with the interface adapter. There may be settings (baud rate, parity, etc.) that must be adjusted before using the peripheral device.

1. PERMANENTLY connect the interface adapter (1) to the connector of the supported device (2). The adapter should always stay connected to the supported device. [To disconnect, remove the cabling (3), NOT the adapter.]



Interconnection Diagram

2. Connect one end of the cabling (3) to the interface adapter and the other end to one of the eight serial ports (4) on the Octanet connectivity device.
3. Connect the Tram-net cable (5) to the connector marked Tram-net on the Octanet connectivity device.
4. Connect the other end to one of the **Tram-net** connectors on the back of the Solar 8000M processing unit (6).

Serial Port Indicator Lights

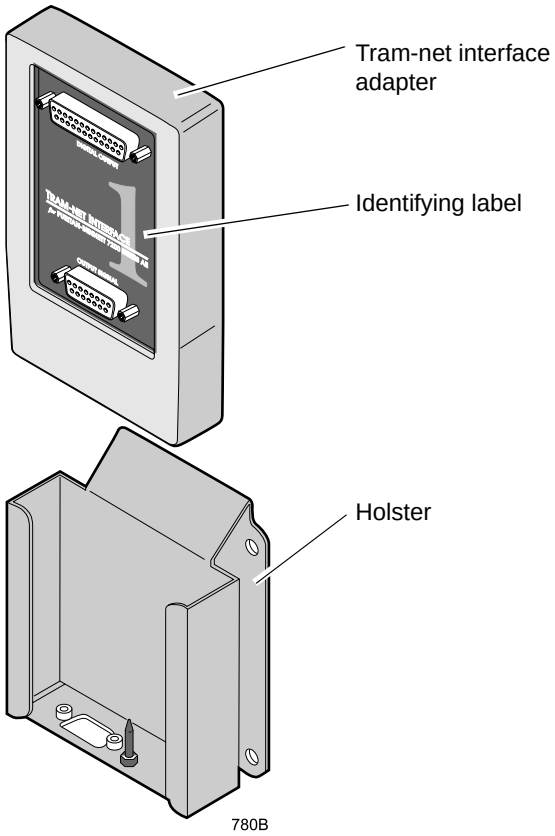
Each serial port has an indicator light located directly above it. This light is used to determine the status of the serial port.

Serial Port Indicator Light

Green State	Yellow State	Status	Description
Off	Off	No connection	Nothing is connected to the associated serial port or the interface connector is not operational.
	On	Communication pending	Cable and interface adapter are connected, but the supported device communication is not yet established.
	Slow blinking (once every 2 seconds)	Communications error	Connected, but communications error with supported device.
	Fast blinking (twice every second)	Other errors	Indicates: 1. Too many supported devices of one type are connected. 2. Interface adapter is malfunctioning. 3. Supported device software is not compatible with the monitor software. 4. Interface adapter is not supported by the monitor software.
On		Working	Communication with the supported device is good.

Tram-net Interface Adapter

A specific Tram-net Interface Adapter (TIA) is needed for each device. Each TIA and the cables needed to connect it are clearly labeled and color-coded.



Tram-net Interface Adapter

WARNING

ALARMS — The peripheral device's alarms must not be turned off or the volume reduced in any way to diminish the importance of the peripheral device as the primary alarm source for parameters monitored by the peripheral device.

The TIA slides into the holster, mounted in a convenient location for your application.

Communication setup and installation instructions are provided with each TIA. Refer to the instructions for specific connection and communication setting information pertaining to each peripheral device.

The TIA cable can be connected to one of the **Tram-net** connectors on the back of the Solar 8000M processing unit.

Displayed Data

The data from a peripheral device that is displayed at the monitor varies with each device. The chart below gives some general information as to what data is available to the monitoring system and how it is handled (trending, alarm broadcast, etc.). The Device Connectivity Chart at the beginning of this chapter has more detailed information regarding waveforms and alarms.

Peripheral Device Data and the Monitoring System

Peripheral Device Type	Waveforms[1, 3]	Parameter Windows	Trends	Alarm Broadcast[3]	Graphing	Data to a Central Station[2]
Pulse Oximeters	No	Yes	Yes	Yes	Yes	No
Transcutaneous monitors	No	Yes	Yes	Yes	Yes	No
Ventilators	Yes	Yes	Yes	Yes	Yes	Limited
Gas Analyzers	Yes	Yes	Yes	Yes	Yes	Yes
Continuous Cardiac Output	No	Yes	Yes	Yes	Yes	No
IV Pumps	No	No	No	Yes	No	No
Urometers	No	Yes	Yes	No	Yes	No
Anesthesia Machines	Yes	Yes	Yes	Yes	Yes	Yes
BIS Monitor	No	Yes	Yes	No	Yes	No
NICO Monitor	Yes	Yes	Yes	Yes	Yes	Limited
POC Blood Gas Monitors	No	Yes	Yes	No	No	No

[1]Octanet supports only digital waveforms; TIA supports analog and digital waveforms.

[2]CIC version 1.0 and subsequent, Centralscope version 10B and subsequent.

[3]Refer to Device Connectivity Chart at the beginning of this chapter.

Parameters

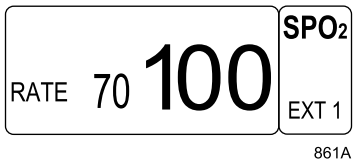
As stated previously, the parameters displayed at the monitor from a peripheral device vary from device to device. Ventilators, gas analyzers, continuous cardiac output devices, and anesthesia machines are capable of sending a number of parameters to the patient monitor. In some cases, not all can be displayed at one time. To view a list of available parameters, look for a menu option such as *SELECT PARAMETERS* or *DISPLAY PARAMETER*. Select the menu option to open a popup list of the parameters that the peripheral device sends to the monitor. You can then select parameters for display from this popup list.

Parameter Windows and Menus

Examples of parameter windows and menus are shown below for the different device types. The data displayed in the parameter window may vary with each device. Not all menu options are available with all devices.

Pulse Oximeters

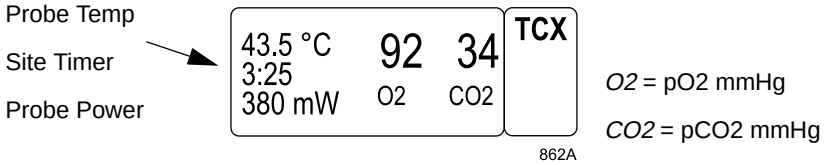
The SPO2 parameter window displays a saturation value and a pulse rate. The *EXT* (#) indicates the data is from an external source. There is no associated waveform or parameter menu.



External SpO2 Parameter Window

Transcutaneous Monitors

A transcutaneous monitor's parameter window is labeled *TCX*. There is no parameter menu.



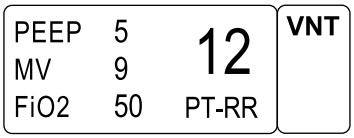
Transcutaneous Monitor Parameter Window

Ventilators

A parameter window labeled *VNT* is displayed for ventilators. The data displayed varies among ventilator devices. Use the parameter menu to change the parameters displayed.

NOTE

Some ventilators may also have a CO2 window and menu. Refer to the Gas Analyzers section in this chapter for this information.



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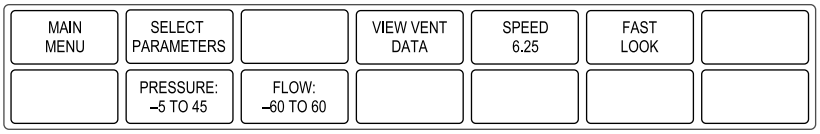
Ventilator Parameter Window



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Ventilator Parameter Menu

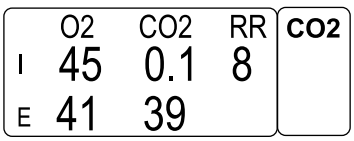
- *SELECT PARAMETERS* — Opens a popup menu to select parameters for display in the parameter window.
- *VIEW VENT DATA* — Enters the vitals signs program to view stored ventilator data.
- *SPEED* — Opens a popup menu to change the sweep speed of the ventilator waveform on the monitor.
- *FAST LOOK* — Opens an information window that shows all ventilator data for that point in time.
- *PRESSURE* — Opens a popup menu to select a scale for the ventilator pressure waveform (centimeters of water).
- *FLOW* — Opens a popup menu to select a scale for the ventilator flow waveform (liters per minute).

Gas Analyzers

Gas analyzers provide two parameter windows, one with CO2 information and the other with gas information. Each parameter window may have a parameter menu. The data in the parameter windows may be organized differently depending on the peripheral device connected.

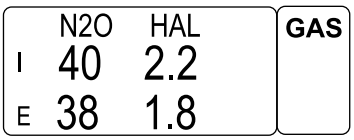
NOTE

Only one CO2 parameter can be displayed at one time on the monitor. The monitor recognizes the first CO2 source and ignores any subsequent ones.



865A

CO2 Parameter Window



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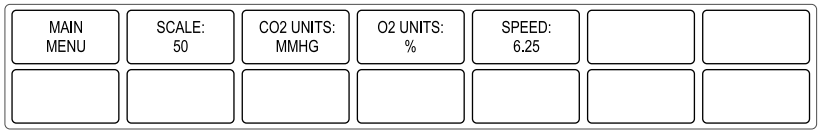
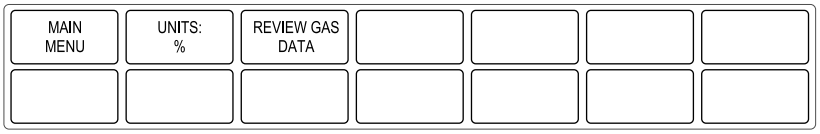
Gas Parameter Window



867A

CO2 Parameter Menu

- *SCALE* — Opens a popup menu to change the scale of the CO2 waveform on the monitor.
- *UNITS* — Opens a popup menu to change the units of measure for the applicable parameter.
- *SPEED* — Opens a popup menu to change the sweep speed of the CO2 waveform on the display.



Gas Parameter Menu

- *UNITS* — Opens a popup menu to change the units of measure for all the gas parameters.
- *REVIEW GAS DATA* — Enter the tabular trends (vital signs) program to view stored gas data.

Continuous Cardiac Output

A parameter window labeled *CCO* is displayed for these devices. There is also a CCO parameter menu.

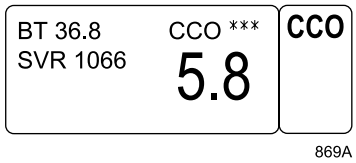
An additional SVO2 parameter window may be displayed with some continuous cardiac output devices. There is no parameter menu for this window.

NOTE

Only one SVO2 parameter can be displayed at one time on the monitor. The monitor recognizes the first SVO2 source and ignores any subsequent ones.

NOTE

Asterisks are displayed to indicate signal strength. Three asterisks indicate a good signal, two indicate an average signal, and one indicates a weak signal. The signal strength asterisks for the CCO parameter may not be available with all devices.



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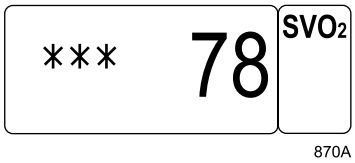
CCO Parameter Window



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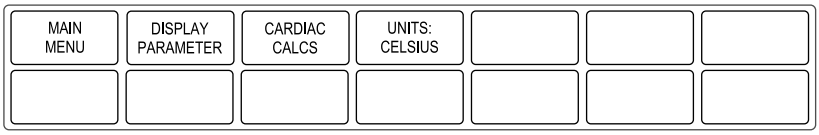
SVO2 Parameter Window



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CCO Parameter Menu

- *DISPLAY PARAMETER* — Opens a popup menu to select parameters for display in the parameter window.
- *CARDIAC CALCS* — Enters the cardiac calculations program.
- *UNITS* — Select Celsius or Fahrenheit as the units of measure for blood temperature (*BT*).

NOTE

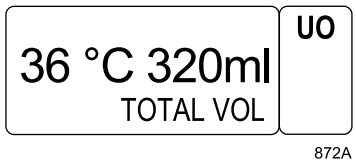
To distinguish a CCO value from a CO value, a lowercase “c” always precedes a parameter label related to CCO.

IV Pumps

The monitor displays no parameter window or menu for IV pumps. It does broadcast alarms.

Urometers

A parameter window labeled *UO* is displayed for urometer devices. There is no parameter menu.



Urometer Parameter Window

NOTE

Temperature is displayed and trended as an indicator of core temperature.

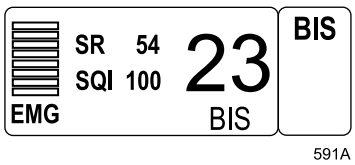
Anesthesia Machines

Up to three parameter windows and menus may appear on the monitor when interfacing with an anesthesia machine — CO2, GAS, and VNT.

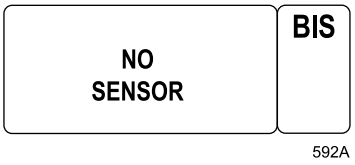
Refer to the Ventilators section and the Gas Analyzers section in this chapter for examples of these parameter windows and associated parameter menus.

BIS Monitor

A parameter window labeled *BIS* is displayed for the BIS monitor. There is no parameter menu.



BIS Parameter Window Normal



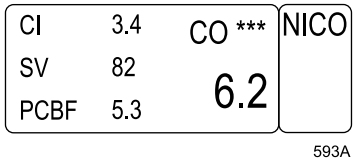
Active BIS Message Window

NICO Monitor

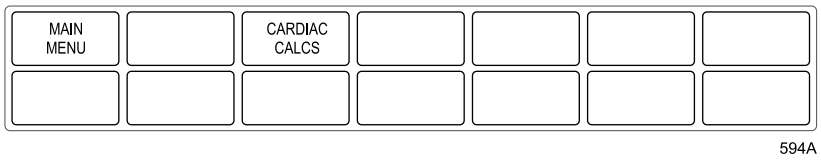
Up to four parameter windows can be displayed when interfacing with a NICO (non-invasive cardiac output) monitor—RM (respiratory mechanics), CO2, SPO2, and NICO.

NOTE

Refer to the individual chapters in this manual for information on CO2 and SPO2 parameters. SPO2 from NICO includes a waveform and associated Size and Speed menu options. For information on the RM parameter, refer to the Respiratory Mechanics Module Operator's Manual. RM from NICO does not include PEEPi or WOBm.



NICO Parameter Window

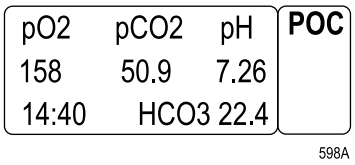


NICO Parameter Menu

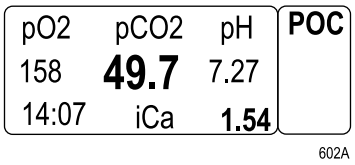
- *CARDIAC CALCS* — Enter the cardiac calculations program.

POC Blood Gas Monitor

A parameter window labeled *POC* is displayed for point-of-care testing devices.



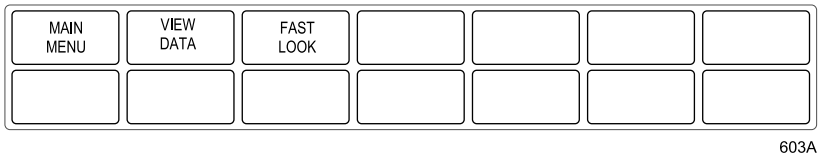
POC Parameter Window Normal



POC Parameter Window with Alarms

NOTE

POC alarm data is displayed in bold numerics in the POC parameter window. POC alarms cannot be changed from a message alarm level.



POC Parameter Menu

- *VIEW DATA* — Enter the vital signs program to view stored POC data.
- *FAST LOOK* — Open an information window with all POC data at that point in time. In the fast look information window, POC data is displayed with a *HI* or *LO* value indicated.

Software Compatibility

Each Octanet cable interface adapter and Tram-net interface adapter is developed with specific peripheral device software. This software information is found on the installation instructions that accompany the adapters.

If you are going to upgrade the software for a peripheral device that already interfaces with an Octanet device or Tram-net interface adapter, please fill out a copy of the Notification of Equipment Upgrade and fax it to GE Medical Systems *Information Technologies*. (This form is found at the end of this chapter.) This is necessary to assure continued compatibility between the peripheral device and GE Medical Systems *Information Technologies* equipment.

Device-Specific Information

Siemens Servo 900C/D/E Ventilators

Be aware that when the ventilator is set to infant mode, the MV data it sends is 10 times greater than the actual value.

Notification of Equipment Upgrade

Software Compatibility

If you are going to upgrade another manufacturer's equipment that already interfaces with a GE Medical Systems *Information Technologies* patient monitor through an Octanet connectivity device, please photocopy this page, fill out all the information and fax it to:

GE Medical Systems *Information Technologies*
Milwaukee, Wisconsin U.S.A.
Attn: Customer Satisfaction
Quality Assurance Department
414-362-2585

We will call the contact person designated below to get the necessary information to determine whether your GE Medical Systems *Information Technologies* equipment will still be compatible with the upgraded equipment.

_____
Contact Person (Please PRINT Name) at Your Hospital/Institution

_____
Phone Number of Contact Person (Include Area Code and Extension)

_____
Hours When Contact Person Can Be Reached

_____
Name of Hospital/Institution

_____

_____
Address of Hospital/Institution (Include Country)

_____
Peripheral Equipment Manufacturer and Model Name

For GE Medical Systems *Information Technologies* Use:

Forwarded to Monitoring Marketing on _____

For your notes

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Appendix A — Adult-ICU Mode Defaults

Following are the monitor defaults for the Adult-ICU mode. You can change these using the monitor defaults feature. Monitor defaults are recalled upon discharge. Refer to Chapter 5, Monitor Setup. This table includes options available with all software packages. Your institution may not have purchased all software packages.

Display Defaults

Patient Age	*Adult*
Display Mode	*Individual*
Color Format	*Transducer*
Primary ECG	*II*
ECG Waveform 2	*V1*
Arrhythmia	*Full (On for Basic)*
Detect Pace	*Off*
Arterial Rate	*On*
Lead Analysis	*Multi-lead*
ST Analysis	*Off*
ST Templates	*Off*
ST V Lead	*V5*
ST Template 1	*II*
ST Template 2	*V5*
ST Template 3	*I*
Adjust ST Point	*J + 60 MS*
12 LD on ST History	*Off*
ECG WF Speed	*25*
Graph Waveform 2	*ART*
Graph Waveform 3	*Off*
Graph Waveform 4	*Off*
Alarm Graph	*On*
Timed Graph	*Continuous*
ART Disconnect	*On*
Smart BP	*On*

Display Defaults

Arterial Scale	*160*
PA Scale	*60*
CVP-RA-UVC Scale	*30*
LA Scale	*30*
ICP Scale	*30*
SP Scale	*160*
BP WF Speed	*25*
CO2 Scale	*50*
CO2 WF Speed	*6.25*
O2 Scale	*15-100*
NBP Auto	*Off*
Adult Cuff Press	*160 mmHg*
Ped Cuff Pressure	*140 mmHg*
Neo Cuff Pressure	*110 mmHg*
CO Catheter	*Baxter*
CO Inj Temp	*In-Line*
CO Size	*7.5*
CO Inj Vol	*10CC*
CO Auto Mode	*On*
N2O Compensation	*0-40% N2O*
O2 Compensation	*0-60% O2*
RR Parameter	*Off*
RR Lead	*II*
RR WF Speed	*25*
SPO2 WF Speed	*25*
View On Alarm	*Off*
VOA Broadcast	*Off*
VOA Alert Tone	*Off*
Remote Alarm Level	*Crisis*
Alarm Volume Off	*Enable*
Min Alarm Volume	*10%*

Display Defaults

Alarm Volume	*70%*
Silence Alarm	*Normal*
QRS Volume	*Off*
Rate Volume	*Off*
ECG Leads Fail	*Sys Warning*
SPO2 Probe Off	*Sys Warning*
SPO2 Pulse Search	*Sys Advisory*
Monitor ISO/DES	*Isoflurane*
Display Limits	*On*
Display Units	*Off*
Units For Height	*CM*
Units For Weight	*KG*
Temperature Units	*C DEG*
CO2 Units	*MMHG*
O2 Units	*%*
Gas Units	*%*
NBP Limits Type	*Systolic*
Arterial Limits Type	*Systolic*
PA Limits Type	*Diastolic*
Menu Timeout	*5 minutes*
ECG Filter	*Monitoring*
BP Filter	*12 Hz*
NO ECG Comm Alarm	*Off*
QRS Width	*Normal*
CO2 Display Mode	*Auto*
RM Display Par 1	*TVm*
RM Display Par 2	*MVm*
RM Display Par 3	*PIP*
RM Display Par 4	*PEEP*
Discharge Alert	*Off*
TC Site Time	*4:00*
TC Site Temp	*45.0 °C*
TC Units	*mmHg*

Display Defaults

TC Severinghaus	*Off*
RM WF Speed	*6.25*
Vent WF Speed	*6.25*
Display MAC Value	*Off*
Disable SAM Hal	*Off*
Disable SAM Enf	*Off*
ICG Primary Par	*CI*
ICG Secondary Par1	*CO*
ICG Secondary Par2	*SVR*
ICG Secondary Par3	*TFC*
Touch Volume	*10%*
Pause Breakthru	*Crisis*
Tech ID Field	*Optional*
Masimo Averaging	*8 secs*
Sat-Seconds	*Off*
BIS Smooth Rate	*30 sec*
EEG Update Rate	*2 sec*
EEG WF Scale	*25 µV/div*
EEG WF Speed	*25*
Spectra Display	*CSA*
EEG Montage	*2 Ch Ref*
EEG Param Display	*SEF*
EEG Trend 1	*SEF*
EEG Trend 2	*MedF*
EEG Trend 3	*SR*
EEG Trend 4	*Amp*

Arrhythmia Alarm Levels

	Crisis	Warning	Advisory	Message
Asystole	✓			
VFib/VTac	✓			
V Tach	✓			
VT > 2	✓			

Arrhythmia Alarm Levels

V Brady	✓			
Couplet				✓
Bigeminy				✓
Acc Vent				✓
Pause				✓
Trigeminy				✓
R on T				✓
PVC				✓
Tachy				✓
Brady				✓
Irregular				✓

Parameter Alarm Levels

	Crisis	Warning	Advisory	Message
HR		✓		
CO2 No Breath		✓		
RM No Resp		✓		
PVC			✓	
ST			✓	
ART			✓	
PA			✓	
CVP			✓	
CO2			✓	
NBP			✓	
SPO2			✓	
FEM			✓	
UAC			✓	
GAS			✓	
VNT			✓	
RA			✓	

Parameter Alarm Levels

UVC			✓	
LA			✓	
ICP			✓	
SP			✓	
SVO2			✓	
TC			✓	
BIS			✓	
ART Rate				✓
SPO2 Rate				✓
BT				✓
FEM Rate				✓
UAC Rate				✓
POC				✓
CCO				✓
ICG				✓
NICO				✓
RR				✓
Resp Apnea				✓
TMP				✓

Parameter Limits

	Low	High
HR	*50*	*150*
PVC/min	—	*6*
ST-I	*-2.0*	*2.0*
ST-II	*-2.0*	*2.0*
ST-III	*-2.0*	*2.0*
ST-V1	*-2.0*	*2.0*
ST-AVL	*-2.0*	*2.0*
ST-AVF	*-2.0*	*2.0*
ST-AVR	*-2.0*	*2.0*

Parameter Limits

	Low	High
ST-V2	-2.0	2.0
ST-V3	-2.0	2.0
ST-V4	-2.0	2.0
ST-V5	-2.0	2.0
ST-V6	-2.0	2.0
NBP-S	80	200
NBP-D	20	120
NBP-M	40	140
ART-S	80	200
ART-D	20	120
ART-M	40	140
ART-R	50	150
FEM-S	80	200
FEM-D	20	120
FEM-M	40	140
FEM-R	50	150
UAC-S	80	200
UAC-D	20	120
UAC-M	40	140
UAC-R	50	150
PA-S	-99	350
PA-D	-99	350
PA-M	-99	350
CVP	-99	350
RA	-99	350
UVC	-99	350
LA	-99	350
ICP	-99	350
SP	-99	350
CO2-Exp	-1	50
CO2-Insp	—	5
CO2-Resp	5	30

Parameter Limits

	Low	High
No Breath	—	20
SpO2	90	105
SpO2-R	50	150
BT	30.0	42.0
SVO2	60	80
RR	5	30
RR-Apnea	—	20
TEMP 1	30.0°C/86.0°F	42.0°C/107.6°F
TEMP 2	30.0°C/86.0°F	42.0°C/107.6°F
O2-Insp	18	102
O2-Exp	-1	102
N2O-Insp	-1.0	80.0
N2O-Exp	-1.0	80.0
N2-Insp	-1.0	85.0
N2-Exp	-1.0	85.0
SEV-Insp	-1.0	7.0
SEV-Exp	-1.0	7.0
DES-Insp	-1.0	12.0
DES-Exp	-1.0	12.0
ENF-Insp	-1.0	7.0
ENF-Exp	-1.0	7.0
HAL-Insp	-1.0	7.0
HAL-Exp	-1.0	7.0
HE-Insp	-1.0	7.0
HE-Exp	-1.0	7.0
ISO-Insp	-1.0	7.0
ISO-Exp	-1.0	7.0
AR-Insp	-1.0	7.0
AR-Exp	-1.0	7.0
RM No Resp	—	20
TC O2	60	90
TC CO2	35	45

Parameter Priority Defaults

The following parameters, when monitored, always appear in parameter windows at the right side of the display.

Parameter 1	*ECG*
Parameter 2	*ECG*
Parameter 3	*ART*
Parameter 4	*PA*
Parameter 5	*CVP*
Parameter 6	*CO2*

The highlighted parameters below appear in parameter windows at the bottom of the display only when there is no room at the side.

GAS	RM	SPO2*	BIS
NBP	CVP*	CO*	ALARMS
ART	RA*	CCO	NICO
FEM	UVC*	RESP*	
UAC	LA*	TEMP*	
PA	ICP*	POC	
CO2	SP*	TC	
VENT*	SVO2*	UO*	

* MAY BE DISPLAYED AS REDUCED SIZE (determined by software).

For your notes

Appendix B — Neonatal-ICU Mode Defaults

Following are the monitor defaults for the Neonatal-ICU mode. You can change these using the monitor defaults feature. Monitor defaults are recalled upon discharge. Refer to Chapter 5, Monitor Setup. This table includes options available with all software packages. Your institution may not have purchased all software packages.

Display Defaults

Patient Age	*0-2 years*
Display Mode	*Individual*
Color Format	*CRG Plus*
Primary ECG	*II*
ECG Waveform 2	*Off*
Arrhythmia	*Lethal*
Detect Pace	*Off*
Arterial Rate	*On*
Lead Analysis	*Multi-lead*
ST Analysis	*Off*
ST Templates	*Off*
ST V Lead	*V5*
ST Template 1	*II*
ST Template 2	*V5*
ST Template 3	*I*
Adjust ST Point	*J + 30 MS*
12 LD on ST History	*Off*
ECG WF Speed	*25*
Graph Waveform 2	*ART*
Graph Waveform 3	*RR*
Graph Waveform 4	*Off*
Alarm Graph	*Off*
Timed Graph	*Continuous*
Arterial Scale	*100*
PA Scale	*60*

Display Defaults

CVP-RA-UVC Scale	*30*
LA Scale	*30*
ICP Scale	*30*
SP Scale	*160*
BP WF Speed	*25*
CO2 Scale	*50*
CO2 WF Speed	*6.25*
O2 Scale	*15-100*
NBP Auto	*Off*
Adult Cuff Press	*160 mmHg*
Ped Cuff Pressure	*140 mmHg*
Neo Cuff Pressure	*110 mmHg*
CO Catheter	*Baxter*
CO Inj Temp	*In-Line*
CO Size	*7.5*
CO Inj Vol	*10CC*
CO Auto Mode	*On*
N2O Compensation	*0-40% N2O*
O2 Compensation	*0-60% O2*
RR Parameter	*On*
RR Lead	*II*
RR WF Speed	*25*
SPO2 WF Speed	*25*
View On Alarm	*Off*
VOA Broadcast	*Off*
VOA Alert Tone	*Off*
Remote Alarm Level	*Advisory*
Alarm Volume Off	*Disable*
Min Alarm Volume	*10%*
Alarm Volume	*70%*
Silence Alarm	*Normal*

Display Defaults

QRS Volume	*Off*
Rate Volume	*Off*
ECG Leads Fail	*Sys Warning*
SPO2 Probe Off	*Sys Warning*
SPO2 Pulse Search	*Sys Advisory*
Monitor ISO/DES	*Isoflurane*
Display Limits	*On*
Display Units	*Off*
Units For Height	*CM*
Units For Weight	*KG*
Temperature Units	*C DEG*
CO2 Units	*MMHG*
O2 Units	*%*
Gas Units	*%*
NBP Limits Type	*Systolic*
Arterial Limits Type	*Systolic*
PA Limits Type	*Diastolic*
Menu Timeout	*5 minutes*
ECG Filter	*Monitoring*
BP Filter	*12 Hz*
NO ECG Comm Alarm	*Off*
QRS Width	*Narrow*
CO2 Display Mode	*Auto*
RM Display Par 1	*TVm*
RM Display Par 2	*MVm*
RM Display Par 3	*PIP*
RM Display Par 4	*PEEP*
Discharge Alert	*Off*
TC Site Time	*4:00*
TC Site Temp	*43.0 °C*
TC Units	*mmHg*
TC Severinghaus	*Off*
RM WF Speed	*6.25*

Display Defaults

Vent WF Speed	*6.25*
Display MAC Value	*Off*
Disable SAM Hal	*Off*
Disable SAM Enf	*Off*
ICG Primary Par	*CI*
ICG Secondary Par1	*CO*
ICG Secondary Par2	*SVR*
ICG Secondary Par3	*TFC*
Touch Volume	*10%*
Pause Breakthru	*Crisis*
Tech ID Field	*Optional*
Masimo Averaging	*8 secs*
Sat-Seconds	*Off*
BIS Smooth Rate	*30 sec*
EEG Update Rate	*2 sec*
EEG WF Scale	*25 µV/div*
EEG WF Speed	*25*
Spectra Display	*CSA*
EEG Montage	*2 Ch Ref*
EEG Param Display	*SEF*
EEG Trend 1	*SEF*
EEG Trend 2	*MedF*
EEG Trend 3	*SR*
EEG Trend 4	*Amp*

Arrhythmia Alarm Levels

	Crisis	Warning	Advisory	Message
Asystole	✓			
VFib/VTac	✓			
Brady	✓			

Parameter Alarm Levels

	Crisis	Warning	Advisory	Message
Resp apnea	✓			
HR		✓		
VNT		✓		
CO2 no breath		✓		
RM no resp		✓		
PVC/min			✓	
ST			✓	
UAC			✓	
UVC			✓	
SPO2			✓	
NBP			✓	
CO2			✓	
ART			✓	
FEM			✓	
GAS			✓	
PA			✓	
CVP			✓	
RA			✓	
LA			✓	
ICP			✓	
SP			✓	
SVO2			✓	
TC			✓	
UAC rate				✓
RR				✓
SPO2 rate				✓
ART rate				✓
FEM rate				✓
POC				✓

Parameter Alarm Levels

TMP				✓
BT				✓
CCO				✓
NICO				✓

Parameter Limits

	Low	High
HR	*90*	*200*
PVC	—	*6*
ST-I	*-2.0*	*2.0*
ST-II	*-2.0*	*2.0*
ST-III	*-2.0*	*2.0*
ST-V1	*-2.0*	*2.0*
ST-AVL	*-2.0*	*2.0*
ST-AVF	*-2.0*	*2.0*
ST-AVR	*-2.0*	*2.0*
ST-V2	*-2.0*	*2.0*
ST-V3	*-2.0*	*2.0*
ST-V4	*-2.0*	*2.0*
ST-V5	*-2.0*	*2.0*
ST-V6	*-2.0*	*2.0*
NBP-S	*40*	*100*
NBP-D	*20*	*60*
NBP-M	*30*	*70*
ART-S	*40*	*100*
ART-D	*20*	*60*
ART-M	*30*	*70*
ART-R	*90*	*200*
FEM-S	*40*	*100*
FEM-D	*20*	*60*
FEM-M	*30*	*70*
FEM-R	*90*	*200*

Parameter Limits

	Low	High
UAC-S	40	100
UAC-D	20	60
UAC-M	30	70
UAC-R	90	200
PA-S	-99	350
PA-D	-99	350
PA-M	-99	350
CVP	-99	350
RA	-99	350
UVC	-99	350
LA	-99	350
ICP	-99	350
SP	-99	350
CO2-Exp	-1	50
CO2-Insp	—	5
CO2-Resp	15	100
No Breath	—	15
SpO2	88	100
SpO2-R	90	200
BT	30.0°C/86.0°F	42.0°C/107.6°F
SvO2	60	80
RR	15	100
RR-Apnea	—	15
TEMP 1	30.0°C/86.0°F	42.0°C/107.6°F
TEMP 2	30.0°C/86.0°F	42.0°C/107.6°F
O2-Insp	18	102
O2-Exp	-1	102
N2O-Insp	-1.0	80.0
N2O-Exp	-1.0	80.0
N2-Insp	-1.0	85.0
N2-Exp	-1.0	85.0
SEV-Insp	-1.0	7.0

Parameter Limits

	Low	High
SEV-Exp	-1.0	7.0
DES-Insp	-1.0	12.0
DES-Exp	-1.0	12.0
ENF-Insp	-1.0	7.0
ENF-Exp	-1.0	7.0
HAL-Insp	-1.0	7.0
HAL-Exp	-1.0	7.0
HE-Insp	-1.0	7.0
HE-Exp	-1.0	7.0
ISO-Insp	-1.0	7.0
ISO-Exp	-1.0	7.0
AR-Insp	-1.0	7.0
AR-Exp	-1.0	7.0
RM No Resp	—	20
TC O2	60	90
TC CO2	35	45

Parameter Priority Defaults

The following parameters, when monitored, always appear in parameter windows on the right side of the display.

Parameter 1	*ECG*
Parameter 2	*UAC*
Parameter 3	*UVC*
Parameter 4	*RR*
Parameter 5	*SPO2*
Parameter 6	*VENT*

The highlighted parameters below appear in parameter windows at the bottom of the display only when there is no room at the side.

VENT*	RESP*	SPO2*	BIS
RM	NBP	SVO2*	ALARMS
ART	CVP*	TC	NICO
FEM	RA*	TEMP*	
UAC	UVC*	CO*	
PA	LA*	CCO	
CO2	ICP*	POC	
GAS	SP*	UO*	

* MAY BE DISPLAYED AS REDUCED SIZE (determined by software).

For your notes

Appendix C — Operating Room Mode Defaults

Following are the monitor defaults for the Operating Room mode. You can change these using the monitor defaults feature. Monitor defaults are recalled upon discharge. Refer to Chapter 5, Monitor Setup. This table includes options available with all software packages. Your institution may not have purchased all software packages.

Display Defaults

Patient Age	*Adult*
Display Mode	*Individual*
Color Format	*Transducer*
Primary ECG	*II*
ECG Waveform 2	*ST*
Arrhythmia	*Off*
Detect Pace	*Off*
Arterial Rate	*On*
Lead Analysis	*Multi-lead*
ST Analysis	*On*
ST Templates	*On*
ST V Lead	*V5*
ST Template 1	*II*
ST Template 2	*V5*
ST Template 3	*I*
Adjust ST Point	*J + 60 MS*
12 LD on ST History	*Off*
ECG WF Speed	*25*
Graph Waveform 2	*ART*
Graph Waveform 3	*Off*
Graph Waveform 4	*Off*
Alarm Graph	*Off*
Timed Graph	*20 seconds*
ART Disconnect	*Off*
Smart BP	*On*

Display Defaults

Arterial Scale	*160*
PA Scale	*60*
CVP-RA-UVC Scale	*30*
LA Scale	*30*
ICP Scale	*30*
SP Scale	*160*
BP WF Speed	*25*
CO2 Scale	*50*
CO2 WF Speed	*6.25*
O2 Scale	*15-100*
NBP Auto	*Off*
Adult Cuff Press	*160 mmHg*
Ped Cuff Pressure	*140 mmHg*
Neo Cuff Pressure	*110 mmHg*
CO Catheter	*Baxter*
CO Inj Temp	*In-Line*
CO Size	*7.5*
CO Inj Vol	*10CC*
CO Auto Mode	*Off*
N2O Compensation	*0-40% N2O*
O2 Compensation	*0-60% O2*
RR Parameter	*Off*
RR Lead	*II*
RR WF Speed	*25*
SPO2 WF Speed	*25*
View On Alarm	*Off*
VOA Broadcast	*Off*
VOA Alert Tone	*Off*
Remote Alarm Level	*Crisis*
Alarm Volume Off	*Enable*
Min Alarm Volume	*10%*

Display Defaults

Alarm Volume	*20%*
Silence Alarm	*Normal*
QRS Volume	*Off*
Rate Volume	*20%*
ECG Leads Fail	*Sys Advisory*
SPO2 Probe Off	*Sys Warning*
SPO2 Pulse Search	*Sys Advisory*
Monitor ISO/DES	*Isoflurane*
Display Limits	*Off*
Display Units	*Off*
Units For Height	*CM*
Units For Weight	*KG*
Temperature Units	*C DEG*
CO2 Units	*MMHG*
O2 Units	*%*
Gas Units	*%*
NBP Limits Type	*Systolic*
Arterial Limits Type	*Systolic*
PA Limits Type	*Diastolic*
Menu Timeout	*5 minutes*
ECG Filter	*Moderate*
BP Filter	*12 Hz*
NO ECG Comm Alarm	*Off*
QRS Width	*Normal*
CO2 Display Mode	*Auto*
RM Display Par 1	*TVm*
RM Display Par 2	*MVm*
RM Display Par 3	*PIP*
RM Display Par 4	*PEEP*
Discharge Alert	*Off*
TC Site Time	*4:00*
TC Site Temp	*45.0 °C*
TC Units	*mmHg*

Display Defaults

TC Severinghaus	*Off*
RM WF Speed	*6.25*
Vent WF Speed	*6.25*
Display MAC Value	*Off*
Disable SAM Hal	*Off*
Disable SAM Enf	*Off*
ICG Primary Par	*CI*
ICG Secondary Par1	*CO*
ICG Secondary Par2	*SVR*
ICG Secondary Par3	*TFC*
Touch Volume	*10%*
Pause Breakthru	*Crisis*
Tech ID Field	*Optional*
Masimo Averaging	*8 secs*
Sat-Seconds	*Off*
BIS Smooth Rate	*30 sec*
EEG Update Rate	*2 sec*
EEG WF Scale	*25 µV/div*
EEG WF Speed	*25*
Spectra Display	*CSA*
EEG Montage	*2 Ch Ref*
EEG Param Display	*SEF*
EEG Trend 1	*SEF*
EEG Trend 2	*MedF*
EEG Trend 3	*SR*
EEG Trend 4	*Amp*

Arrhythmia Alarm Levels

	Crisis	Warning	Advisory	Message
Asystole			✓	
VFib/VTac			✓	
V Tach			✓	

Parameter Alarm Levels

	Crisis	Warning	Advisory	Message
RM no resp		✓		
HR			✓	
PVC			✓	
ST			✓	
NBP			✓	
ART			✓	
PA			✓	
CVP			✓	
CO2			✓	
CO2 no breath			✓	
GAS			✓	
SPO2			✓	
FEM			✓	
UAC			✓	
VNT			✓	
RA			✓	
UVC			✓	
LA			✓	
ICP			✓	
SP			✓	
SVO2			✓	
TC			✓	
ART rate				✓
TMP				✓
SPO2 rate				✓
BT				✓
FEM rate				✓
UAC rate				✓

Parameter Alarm Levels

POC				✓
CCO				✓
ICG				✓
NICO				✓
RR				✓
Resp apnea				✓

Parameter Limits

	Low	High
HR	*-1*	*150*
PVC	*—*	*6*
ST-I	*-2.0*	*2.0*
ST-II	*-2.0*	*2.0*
ST-III	*-2.0*	*2.0*
ST-V1	*-2.0*	*2.0*
ST-AVL	*-2.0*	*2.0*
ST-AVF	*-2.0*	*2.0*
ST-AVR	*-2.0*	*2.0*
ST-V2	*-2.0*	*2.0*
ST-V3	*-2.0*	*2.0*
ST-V4	*-2.0*	*2.0*
ST-V5	*-2.0*	*2.0*
ST-V6	*-2.0*	*2.0*
NBP-S	*40*	*200*
NBP-D	*20*	*120*
NBP-M	*40*	*140*
ART-S	*40*	*200*
ART-D	*20*	*120*
ART-M	*40*	*140*
ART-R	*-1*	*150*
FEM-S	*40*	*200*
FEM-D	*20*	*120*

Parameter Limits

	Low	High
FEM-M	40	140
FEM-R	-1	150
UAC-S	40	200
UAC-D	20	120
UAC-M	40	140
UAC-R	-1	150
PA-S	-99	350
PA-D	-99	350
PA-M	-99	350
CVP	-99	350
RA	-99	350
UVC	-99	350
LA	-99	350
ICP	-99	350
SP	-99	350
CO2-Exp	-1	50
CO2-Insp	—	5
CO2-Resp	1	200
No Breath	—	30
SpO2	90	105
SpO2-R	-1	150
BT	0.0	42.0
SvO2	60	80
RR	1	200
RR-Apnea	—	20
TEMP 1	0.0	42.0
TEMP 2	0.0	42.0
O2-Insp	18	102
O2-Exp	-1	102
N2O-Insp	-1.0	80.0
N2O-Exp	-1.0	80.0
N2-Insp	-1.0	85.0

Parameter Limits

	Low	High
N2-Exp	-1.0	85.0
SEV-Insp	-1.0	7.0
SEV-Exp	-1.0	7.0
DES-Insp	-1.0	12.0
DES-Exp	-1.0	12.0
ENF-Insp	-1.0	7.0
ENF-Exp	-1.0	7.0
HAL-Insp	-1.0	7.0
HAL-Exp	-1.0	7.0
HE-Insp	-1.0	7.0
HE-Exp	-1.0	7.0
ISO-Insp	-1.0	7.0
ISO-Exp	-1.0	7.0
AR-Insp	-1.0	7.0
AR-Exp	-1.0	7.0
RM No Resp	—	20
TC O2	60	90
TC CO2	35	45

Parameter Priority Defaults

The following parameters, when monitored, always appear in parameter windows on the right side of the display.

Parameter 1	*ECG*
Parameter 2	*NBP*
Parameter 3	*ART*
Parameter 4	*PA*
Parameter 5	*CVP*
Parameter 6	*CO2*

The highlighted parameters below appear in parameter windows at the bottom of the display only when there is no room at the side.

CO2	FEM	LA*	BIS
GAS	UAC	ICP*	ALARMS
SPO2*	PA	SP*	NICO
CO*	VENT*	SVO2*	
CCO	RM	RESP*	
TEMP*	CVP*	POC	
NBP	RA*	TC	
ART	UVC*	UO*	

* MAY BE DISPLAYED AS REDUCED SIZE (determined by software).

For your notes

Appendix D — Monitor Defaults Worksheet

You can customize alarm limts and levels, as well as numerous display options. Your settings can be set up as monitor defaults, to be recalled with each discharge procedure. Refer to Chapter 5, Monitor Setup, for details.

This worksheet is provided as an optional reference tool. Fill it out and keep it in a prominent place to refer to your setup. Before filling it out, you may want to make additional copies of the worksheet for future use.

_____

Customer Authorization Signature

Date: _____ Unit: _____

Monitor Type and Default Number (circle one):

Adult-ICU	0	1	2	3	4
Neonatal-ICU	0	1	2	3	4
Operating Room	0	1	2	3	4

NOTE

Changing the patient-monitor type after setup erases your monitor defaults and reinstates the factory defaults.

Display Defaults

Patient Age	
Display Mode	
Color Format	
Primary ECG	
ECG Waveform 2	
Arrhythmia	
Detect Pace	
Arterial Rate	
Lead Analysis	
ST Analysis	

Display Defaults

ST Templates	
ST V Lead	
ST Template 1	
ST Template 2	
ST Template 3	
Adjust ST Point	
12 LD on ST History	
ECG WF Speed	
Graph Waveform 2	
Graph Waveform 3	
Graph Waveform 4	
Alarm Graph	
Timed Graph	
ART Disconnect	
Smart BP	
Arterial Scale	
PA Scale	
CVP-RA-UVC Scale	
LA Scale	
ICP Scale	
SP Scale	
BP WF Speed	
CO2 Scale	
CO2 WF Speed	
O2 Scale	
NBP Auto	
Adult Cuff Press	
Ped Cuff Pressure	
Neo Cuff Pressure	
CO Catheter	
CO Inj Temp	

Display Defaults	
CO Size	
CO Inj Vol	
CO Auto Mode	
N2O Compensation	
O2 Compensation	
RR Parameter	
RR Lead	
RR WF Speed	
SPO2 WF Speed	
View On Alarm	
VOA Broadcast	
VOA Alert Tone	
Remote Alarm Level	
Alarm Volume Off	
Min Alarm Volume	
Alarm Volume	
Silence Alarm	
QRS Volume	
Rate Volume	
ECG Leads Fail	
SPO2 Probe Off	
SPO2 Pulse Search	
Monitor ISO/DES	
Display Limits	
Display Units	
Units For Height	
Units For Weight	
Temperature Units	
CO2 Units	
O2 Units	
NBP Limits Type	
Arterial Limits Type	
PA Limits Type	

Display Defaults	
Menu Timeout	
ECG Filter	
BP Filter	
NO ECG Comm Alarm	
QRS Width	
CO2 Display Mode	
RM Display Par 1	
RM Display Par 2	
RM Display Par 3	
RM Display Par 4	
Discharge Alert	
TC Site Time	
TC Site Temp	
TC Units	
TC Severinghaus	
RM WF Speed	
Vent WF Speed	
Display MAC Value	
Disable SAM Hal	
Disable SAM Enf	
ICG Primary Par	
ICG Secondary Par1	
ICG Secondary Par2	
ICG Secondary Par3	
Touch Volume	
Pause Breakthru	
Tech ID Field	
Masimo Averaging	
Sat-Seconds	
BIS Smooth Rate	
EEG Update Rate	
EEG WF Scale	
EEG WF Speed	

Display Defaults

Spectra Display	
EEG Montage	
EEG Param Display	
EEG Trend 1	
EEG Trend 2	
EEG Trend 3	
EEG Trend 4	

Arrhythmia Alarm Levels

	Crisis	Warning	Advisory	Message
Asystole				
VFib/VTac				
V Tach				
VT > 2				
V Brady				
Couplet				
Bigeminy				
Acc Vent				
Pause				
Trigeminy				
R on T				
PVC				
Tachy				
Brady				
Irregular				

Parameter Alarm Levels

	Crisis	Warning	Advisory	Message
HR				
CO2 No Breath				
RM No Resp				
PVC				
ST				
ART				

Parameter Alarm Levels

PA				
CVP				
CO2				
NBP				
SPO2				
FEM				
UAC				
GAS				
VNT				
RA				
UVC				
LA				
ICP				
SP				
SVO2				
TC				
ART Rate				
SPO2 Rate				
BT				
FEM Rate				
UAC Rate				
POC				
CCO				
ICG				
NICO				
RR				
Resp Apnea				
TMP				

Parameter Default Limits

	Low	High
HR		
PVC		
ST-I		
ST-II		
ST-III		
ST-V1		
ST-AVL		
ST-AVF		
ST-AVR		
ST-V2		
ST-V3		
ST-V4		
ST-V5		
ST-V6		
NBP-S		
NBP-D		
NBP-M		
ART-S		
ART-D		
ART-M		
ART-R		
FEM-S		
FEM-D		
FEM-M		
FEM-R		
UAC-S		
UAC-D		
UAC-M		
UAC-R		
PA-S		
PA-D		
PA-M		

Parameter Default Limits

	Low	High
CVP		
RA		
UVC		
LA		
ICP		
SP		
CO2-Exp		
CO2-Insp		
CO2-Resp		
No Breath		
SpO2		
SpO2-R		
BT		
SvO2		
RR		
RR-Apnea		
TEMP 1		
TEMP 2		
O2-Insp		
O2-Exp		
N2O-Insp		
N2O-Exp		
N2-Insp		
N2-Exp		
SEV-Insp		
SEV-Exp		
DES-Insp		
DES-Exp		
ENF-Insp		
ENF-Exp		
HAL-Insp		
HAL-Exp		

Parameter Default Limits

	Low	High
HE-Insp		
HE-Exp		
ISO-Insp		
ISO-Exp		
AR-Insp		
AR-Exp		
RM No Resp		
TC O2		
TC CO2		

Parameter Priority Defaults

Indicate which parameters you want to have priority in the first 6 positions on the display. ECG always appears first and cannot be changed.

Parameter 1	*ECG*
Parameter 2	
Parameter 3	
Parameter 4	
Parameter 5	
Parameter 6	

Circle the other parameters you want to have priority after position 6. Size of the parameter window determines how many selections you can make (3 full size, 5 reduced size, or combination thereof). The software prevents you from selecting more parameters than allowable.

GAS	RM	SPO2*	BIS
NBP	CVP*	CO*	ALARMS
ART	RA*	CCO	NICO
FEM	UVC*	RESP*	
UAC	LA*	TEMP*	
PA	ICP*	POC	
CO2	SP*	TC	
VENT*	SVO2*	UO*	

* MAY BE DISPLAYED AS REDUCED SIZE (determined by software).

For your notes

Appendix E — Analog Output

ECG Acquisition Modules

The configuration for the analog output from the ECG acquisition modules is detailed below. Analog output is obtained through the Defib Sync connector on the front of the appropriate module. (Refer to the service manual for the specific pin configuration.)

ECG Analog Output:

Top displayed lead including augmented leads. If pace is on there is an enhanced pacer pulse (5 volts at 2 milliseconds) when pacemaker triggering is detected.

In the event of a *LEAD FAIL*, refer to the following:

Lead Failed	ECG Analog Out
RA	III
LA	II
LL	I
V	II
RL	Buzz*

*An RL lead fail causes an all *LEADS FAIL* on the screen and a buzz is output.

Notes:

1. All ECG outputs are 1 volt per millivolt Referred To Input.
2. In single lead mode, if the specified lead is not available, a buzz will be output.

BP Analog Output:

BP analog output is only available on Tram modules with the BP monitoring feature.

NOTE

A buzz will be sent to the analog out if the BP is not zeroed.

- The pressure labeled *ART* (BP 1-4) is sent to the analog out.
- If two or more pressures are labeled *ART*, for example, BP-3 and BP-4, the first (BP-3) will be sent to the analog out.
- If all the BPs are labeled *ART*, then BP-1 will be sent to the analog out.
- If there is no pressure labeled *ART*, then BP-1 will be sent to the analog out.

All BP outputs are 10 mV/mmHg when zeroed.

Digital Synchronization Output:

A digital sync output is available with a return marker on those modules with the defib sync feature. (Refer to the module's service manual for specifications.)

Tram-rac Housing

The analog output from the Tram-rac housing provides the following signals when using the analog output cable. (Refer to the service manual for the specific pin configuration.)

NOTE

The Solar ECG module does not support analog output from the Tram-rac analog output connector. When using the Solar ECG module, analog output is only available from the optional Defib Sync connector on the front of the module.

ECG Analog Output:

NOTE

Refer to the Tram-rac Housing section in Chapter 2, Equipment Overview, for location of the analog output connectors on the various housings.

- Top displayed lead including augmented leads.

In the event of a *LEAD FAIL*, refer to the following:

Lead Failed	ECG Analog Out
RA	III
LA	II
LL	I
V	II
RL	Buzz*

*An RL lead fail causes an all *LEADS FAIL* on the screen and a buzz is output.

- ECG lead II (Buzz if lead II fail)
- ECG lead V (Buzz if lead V fail)

All ECG outputs are 1 volt per millivolt Referred To Input.

BP Analog Output:

NOTE

For BPs coming from a Tram module, a buzz is sent to the analog out if the BP is not zeroed. If the BP source is other than a Tram module, no buzz is sent; instead, the BP waveform is sent but it has an unknown DC voltage offset. All BP outputs are 10 mV/mmHg when zeroed.

- First ART or BP1 if no ART monitored
- BP2 or SPO2 waveform (if available) if BP2 is not present
- BP3 or SPO2 value (if available) if BP3 is not present
- BP4 or resp waveform (if available) if BP4 is not present
- Waveform in slot #5 (Tram-rac housings with 3 or more slots)
- Waveform in slot #6 (Tram-rac housings with 3 or more slots)
- Waveform in slot #7 (Tram-rac 4A housing only)
- Waveform in slot #8 (Tram-rac housings with 3 or more slots)

For your notes

Appendix F — Supplies Information

To ensure patient safety, use only supplies manufactured or recommended by GE Medical Systems *Information Technologies*. Your local sales/service representative can provide current supplies lists or you can contact GE Medical Systems *Information Technologies* Supplies. (Refer to "How to Reach Us" at the front of this manual.)

For your notes

Appendix G — Software Packages

The Solar 8000M monitor comes configured with the Basic software package. Three additional packages can be purchased separately or in any combination. These packages are:

- Cardiac software package
- Cardiopulmonary software package
- High Resolution CRG Trends software package

For more information about these software packages, and for instructions on how to tell which software package(s) are installed on your monitor, refer to the Software Packages section in Chapter 1, The Basics.

Refer to the table below for a comprehensive feature matrix.

Software Packages

Capability or Feature	Basic Software Package	Cardiac Package	Cardio-pulmonary Package	High Resolution CRG Trends
8-trace color display	X			
On-screen invasive BP site labels	X			
Common scale and individual scale BP displays	X			
Right-left overlapping BP scale display	X			
Waveform and numeric alignment	X			
Mentor on-screen operational support	X			
Adult, neonate, and OR customization	X			
User-programmable, monitor default/monitor setup	X			
CRG Plus	X			
Storage of up to 100 CRG events				X
Storage of up to 24 hours of CRG trend data				X
Simultaneous, multi-lead ECG acquisition	X			
3-lead or 5-lead ECG cable compatibility	X			
Pacemaker detection/rejection	X			
Smart-lead fail	X			
All ECG display format	X			

Software Packages

Capability or Feature	Basic Software Package	Cardiac Package	Cardio-pulmonary Package	High Resolution CRG Trends
Lethal arrhythmia detection package (Asystole, VTach, and VFib alarms)	X			
Full arrhythmia package w/alarm level adjust		X		
Multi-lead arrhythmia storage and recall		X		
Multi-lead ST segment measurement—7 leads	X			
12-lead ST segment monitoring—12 leads	X			
Multi-lead ST segment template and trending		X		
Multi-lead ST segment history storage		X		
Selectable ST points		X		
12SL ECG analysis program	X			
Automatic 12 lead on ST alarm	X			
Respiration monitoring and apnea detection	X			
6 invasive BP channels	X			
Invasive BP measurement cursor	X			
Arterial disconnect alarm	X			
Arterial Smart BP function	X			
Intra-aortic balloon pump BP algorithm			X	
PA Wedge measurement program			X	
PA Insert Wedge measurement program			X	
Non-invasive BP (NBP) measurement	X			
NBP cuffs/measurement for adult, pediatric, neonate	X			
NBP manual, automatic, and stat measurement modes	X			
Pulse oximetry monitoring	X			
Temperature monitoring support	X			
Thermodilution cardiac output support			X	
Cardiac computation constants stored for major manufacturers			X	
Cardiac calculations			X	
EtCO2 monitoring support	X			
SvO2 monitoring support	X			
SAM (Smart Anesthesia Multi-gas module)	X			

Software Packages

Capability or Feature	Basic Software Package	Cardiac Package	Cardio-pulmonary Package	High Resolution CRG Trends
TC module support	X			
Tabular trends—24 hr	X			
Graphic trending—24 hr	X			
Pulmonary calculations w/fick CO calculation			X	
Dose calculations—adult/neonate	X			
High/low alarms, all parameters	X			
Alarm window	X			
Multi-level, user-programmable, “graded” alarms package	X			
Laser printer support (via CIC)	X			
PRN 50 support	X			
View other patient (float)	X			
View on alarm	X			
Auto view on alarm (requires Prism information server)	X			
LAN “combo” (telemetry/hardwire monitoring)	X			
Dual Tram-racs	X			
Interfaces via TIA	X			
Interfaces via Octanet	X			
M-Ports	3	1		

For your notes

Appendix H — Solar 8000M Display

The Solar 8000M patient monitor is currently available with the following GE Medical Systems *Information Technologies* displays:

- 15-inch, medical-grade, color CRT display
- 15-inch, medical-grade, flat panel, color LCD display
- 15-inch, computer-grade, color CRT display
- 17-inch, computer-grade, color CRT display

Off-the-shelf (computer-grade) displays are also compatible (see the required and recommended specifications in this appendix).

WARNING
Do not connect a monochrome display to the Solar 8000M monitor. Visual alarm messages may not appear properly.

Purchaser's Responsibility

The display purchaser is responsible for meeting Solar 8000M display specifications. GE Medical Systems *Information Technologies* does not make recommendations regarding specific display models other than those it offers for sale. For questions regarding display specifications or compatibility of displays not purchased from GE Medical Systems *Information Technologies*, contact the display manufacturer.

The GE Medical Systems *Information Technologies* warranty only applies to equipment purchased from GE Medical Systems *Information Technologies*. Service repairs resulting from failures of equipment not purchased from GE Medical Systems *Information Technologies* are billable.

NOTE
An isolation transformer must be used with a computer-grade display to meet UL and IEC specifications.

Medical-Grade Displays

The Solar 8000M patient monitor with a medical-grade display meets applicable UL and IEC specifications for a medical electrical system. For this system, an isolation transformer is not required.

Computer-Grade Displays

The Solar 8000M patient monitor with a computer-grade display meets UL and IEC specifications if an isolation transformer is used, regardless of whether the computer-grade display meets the leakage current specification on its own.

The party assembling or modifying the medical electrical system is responsible to insure compliance with IEC 60601-1-1. Therefore, if GE Medical Systems *Information Technologies* installs a Solar 8000M system with a computer-grade display, GE Medical Systems *Information Technologies* is responsible for meeting the specification.

As a result GE Medical Systems *Information Technologies* will only install computer-grade displays with appropriate isolation transformers. (See the following information.)

Isolation Transformers

Powervar has designed an isolation transformer specifically for this application. Powervar headquarters (listed below) will process orders and drop-ship to any destination requested. When calling Powervar, identify yourself as a GE Medical Systems *Information Technologies* representative/customer to receive the GE Medical Systems *Information Technologies* partnership discount.

Powervar
28457 North Ballard Drive, Suite C
Lake Forest, Illinois 60045
Phone: 800-369-717
Fax: 847-816-8988

Contact your local sales/service representative for part numbers and unit information.

Required Specifications for Computer-Grade CRT Displays

The following are REQUIRED specifications:

Electrical:

Horizontal:	Sync Rate:	48.4 KHz (*see note)
	Sync Input:	TTL negative
Vertical:	Refresh Rate:	60 Hz (*see note)
	Sync Input:	TTL negative
Video:	Non-composite:	0.7Vp-p analog RGB
	Polarity:	Black-negative
	Resolution:	1024 x 768
	Input Impedance:	75 ohms

***NOTE**

Multiscan displays indicate the sync rate and the refresh rate as ranges (e.g., 20 KHz to 80 KHz), rather than a single value. To meet the required specifications, ensure that the ranges indicated on your display include a 48.4 KHz horizontal sync rate and a 60 Hz vertical refresh rate.

Monitor (Display) Connections:

Captive cable, or interconnect cable (processor unit to display):

	15 pin (3 row) Dsub male connector, standard VGA pinout
Connector(s):	15 pin (3 row) Dsub female connector, standard VGA pinout; or 5 BNC connectors

Emissions:	MPR II, CISPR 11B
Agency Approvals:	UL1950, CSA 950, IEC 950, CE

Recommended Specifications for Computer-Grade CRT Displays

The following are RECOMMENDED specifications:

Monitor (Display) Size:	12-inch to 19-inches typical
Input Voltage Range:	90-135 VAC/60 Hz, or 180-270 VAC/50 Hz
Controls:	On/Off, Brightness, Contrast
Environmental:	
Operating Temperature:	10 to 40 degrees C
Humidity:	10 to 95% (non-condensing)
Bandwidth:	60 MHz minimum
Dot Pitch:	0.28 mm maximum
Misconvergence:	0.3 mm maximum
Non-linearity/Geometric Distortion:	2% maximum
Luminance:	>40 foot-lamberts at screen center with 20% white screen
CRT:	Anti-glare coating and transmissiveness of approximately 57%
Mounts:	If the monitor (display) will be mounted, it must accommodate GCX or equivalent mounting GCX Corporation 32 Pamaron Way Novato, CA 94949 415-883-2551

Required Specifications for Computer-Grade Digital Flat Panel Displays

The following are REQUIRED specifications:

Electrical:		
Horizontal:	Sync Rate:	48.4 KHz (*see note)
	Sync Input:	TTL negative
Vertical:	Refresh Rate:	60 Hz (*see note)
	Sync Input:	TTL negative
Video:	TMDS Digital Video DFP 1.0 Compliant	
	Resolution:	1024 x 768

***NOTE**

Multiscan displays indicate the sync rate and the refresh rate as ranges (e.g., 20 KHz to 80 KHz), rather than a single value. To meet the required specifications, ensure that the ranges indicated on your display include a 48.4 KHz horizontal sync rate and a 60 Hz vertical refresh rate.

Monitor (Display) Connections:	
Captive cable, or interconnect cable (processor unit to display):	
	20 pin mini-D ribbon (MDR) male connector
Connector(s):	20 pin mini-D ribbon (MDR) female connector
Emissions:	MPR II, CISPR 11B
Agency Approvals:	UL1950, CSA 950, IEC 950, CE

Recommended Specifications for Computer-Grade Digital Flat Panel Displays

The following are RECOMMENDED specifications:

Monitor (Display) Size:	15-inch to 21-inches typical
Display Characteristics:	Viewing angle ± 70° horizontal minimum; ± 70° vertical minimum
Input Voltage Range:	90-135 VAC/60 Hz, or 180-270 VAC/50 Hz
Controls:	On/Off, Brightness
Environmental:	
Operating Temperature:	10 to 40 degrees C
Humidity:	10 to 95% (non-condensing)
Bandwidth:	65 MHz minimum
Contrast Ratio:	300:1 typical
Brightness:	150 nits minimum
Protective Filter:	Anti-glare hard coat
Mounts:	If the monitor (display) will be mounted, it must accommodate GCX or equivalent mounting GCX Corporation 32 Pamaron Way Novato, CA 94949 415-883-2551

Appendix I — Abbreviations and Symbols

Abbreviations and symbols that you may encounter while reading this manual or using the monitor are listed below with their meanings.

Abbreviations

	A
A	amps
AaDO2	alveolar arterial oxygen gradient
ABG	arterial blood gas
AC	alternating current
ACCV	accelerated ventricular
ACC VENT	accelerated ventricular
ACI	acceleration index
ADT	adult
AHA	American Heart Association
ALRM	alarm
AMP	amplitude, ampere
ANT	anterior
AO2 (aO2)	arterial oxygen saturation
AR	argon, arterial
ARR	arrhythmia
ART	arterial
Async	asynchronous
ASYS	asystole
Auto, AUTO	automatic
a–vO2	arterial venous oxygen content difference
AVF	left foot augmented lead
AVG	average
AVL	left arm augmented lead
AVR	right arm augmented lead

B

Baro	barometric pressure
BE	base excess
BEecf	base excess extracellular fluid
BEb	base excess blood
BGMY	bigeminy
BIS	bispectral index
BP	blood pressure
BPM	beats per minute
BRAD	bradycardia
BSA	body surface area
BT	blood temperature

C

C	Celsius
CAL	calibration
CALC	calculation
CALCS	calculations
CaO2	arterial oxygen content
CARD	cardiac
CC	computation constant
cc, CC	cubic centimeter
CCI	continuous cardiac index
CCO	continuous cardiac output
CCU	critical care unit
CDYN	compliance dynamic
CEd	effective dynamic compliance
CH	channel
CI	cardiac index
cm, CM	centimeter
CO	cardiac output, carbon monoxide
CO2	carbon dioxide

COHb	carboxyhemoglobin
COMM	communication
COMP	compliance
CP	cardiopulmonary
CPLT	couplet
CPP	cerebral perfusion pressure
CPU	central processing unit
CRG	cardiorespirogram
CRT	cathode-ray tube
CS	central station
CSA	compressed spectral array
CvO2	mixed venous oxygen content difference
CVP	central venous pressure

D

D	diastolic
dB	decibel
DC	direct current
DC	discontinue
DDW	Direct Digital Writer
DEFIB, Defib	defibrillator
DES	desflurane
DIA	diastolic
DISCH	discharge
DIV	division
DSA	density modulated spectral array
DSC	digital signal converter
dyn	dyne

E

E	expired
ea–vO2	estimated arterial venous oxygen content difference
eCaO2	estimated arterial oxygen content

ECG	electrocardiograph
eCvO2	estimated mixed venous oxygen content
eDO2I	estimated delivered oxygen index
EEG	electroencephalograph
eg	for example
EMG	electromyograph
ENF	enflurane
eO2CI	estimated oxygen consumption
eO2R	estimated oxygen extraction ratio
eQs/Qt	estimated shunt fraction
Esopho	esophageal
ESU	electrosurgical cautery unit
et al	and others
EtCO2, ETCO2	end-tidal carbon dioxide
ETO	Ethylene Oxide
EX, Exp	expired
EXT	external
	F
F	Fahrenheit
FEM	femoral
FiO2	fraction of inspired oxygen
FR	French (catheter size)
	G
g	gram
GE	General Electric
Gluc	glucose
GTT/CC, gtt/cc	drops per cubic centimeter
	H
HAL	halothane
Hb	hemoglobin
HbO2	oxyhemoglobin

HCO3	bicarbonate
Hct	hematocrit
HE	helium
Hgb	hemoglobin
HIS	hospital information system
HR	heart rate, hour
HT	height
Hz	hertz

I

I	inspired
IABP	intra-aortic balloon pump
iCa	ionized calcium
iCa (N)	ionized calcium normalized to pH 7.4
ICG	impedance cardiography
ICP	intracranial pressure
ICU	intensive care unit
ie	that is
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
IN	inspired
Inc	incorporated
INF	infusion, inferior
INIT	initialization
Inj, INJECT	injectate
Insp	inspired
I-PEEP	intrinsic positive end expiratory pressure
IRRG	irregular
ISO	isoflurane
ISU	inlet select unit
IT	injectate temperature
IV	intravenous

	K
K+	potassium
kg, KG	kilogram
kPa	kilopascal
	L
L	liter, left
LA	left arm, left atrial
LAN	local area network
LAT	lateral
LBS	pounds
LCD	liquid crystal display
LCWI	left cardiac work index
LD	lead
LED	light emitting diode
LL	left leg
LIS	laboratory information system
LVET	left ventricular ejection time
LVSWI	left ventricular stroke work index
	M
M	mean, minute
m	meter
MAP	mean arterial pressure
MAWP	mean airway pressure
MCG	micrograms
MedF	median frequency
MetHb	methemoglobin
MG	milligrams
M-INSP	measured inspiratory time
MIN, min	minute
mL	milliliter
MM, mm	millimeters

MM/S, mm/s	millimeters per second
MMHG, mmHg	millimeters of mercury
M-PEEP	measured positive end expiratory pressure
MRI	magnetic resonance image
MTR	motor
MUNITS	milliunits
mV	millivolt
MV	minute volume
MVm	mechanical minute volume
MVs	spontaneous minute volume
	N
N2	nitrogen
N2O	nitrous oxide
Na+	sodium
NBP	noninvasive blood pressure
NC	non-capture
NEO, Neo	neonatal
NICO	non-invasive cardiac output
NS	non-sense
	O
O2	oxygen
O2CI	oxygen consumption index
O2DI	oxygen delivery index
O2R	oxygen extraction ratio
O2sat	oxygen saturation
O2set	oxygen setting
OR	operating room
oz	ounce
	P
PA	pulmonary artery
PaCO2	partial pressure of carbon dioxide in arterial blood

PAD	pulmonary artery diastolic
Pa/FiO2	oxygenation ratio
PAM	pulmonary artery mean pressure
PaO2	partial pressure of oxygen in arterial blood
PAO2	alveolar pressure
PAUS	pause
PAW, PAWP	pulmonary artery wedge pressure
PBAR	barometric pressure
PCO2, pCO2	partial pressure of arterial carbon dioxide
PCBF	pulmonary capillary blood flow
PEAKP	end inspiratory pressure
PED	pediatric
PEF	peak expiratory flow
PEEP	positive end expiratory pressure
PEEPi	intrinsic positive end expiratory pressure
PEP	pre ejection period
pH	hydrogen ion concentration
PIP	peak inspiratory pressure
pO2	partial pressure of oxygen
PO2	partial pressure of arterial oxygen
POC	point of care
PPLAT	plateau pressure
PT-RR	patient respiration rate
PULM	pulmonary
PVC	premature ventricular complex
PvO2	partial pressure of oxygen in mixed venous
PVR	pulmonary vascular resistance
PVRI	pulmonary vascular resistance index
PWR	power

	Q
QA	quality assurance
QRS	interval of ventricular depolarization
Qs/Qt	shunt fraction
QTY	quantity
	R
R	rate, right
RA	right arm, right atrial
RAM	random access memory
RAWe	resistance (airway) (expiratory)
REF	reference
RES	resistance
RESP	respiration
RF	radio frequency
RHb	reduced hemoglobin
RHY	rhythm
RL	right leg
RM	respiratory mechanics
RMT ALM	remote alarm
RMT VID	remote video
ROM	read-only memory
RR	respiration rate
RRm	mechanical respiration rate
RRs	spontaneous respiration rate
RTFC	artifact
RVSWI	right ventricular stroke work index
	S
S	systolic
SaO2	arterial oxygen saturation
sec	second
SEF	spectral edge frequency

SI	stroke index
SOL	solution
SP	special
SPEC	spectrometer
SPO-RR	spontaneous respiration rate
SpO2	arterial oxygen saturation from pulse oximetry
SQI	signal quality index
SR	suppression ratio
STR	systolic time ratio
SUM	summation
SV	stroke volume
SvO2	mixed venous oxygen saturation
SVR	systemic vascular resistance
SVRI	systemic vascular resistance index
SYNC, Sync	synchronization
SYS	systolic

T

T1	temperature site 1
T2	temperature site 2
TACH	tachycardia
TC, Tc	transcutaneous
TCCO2, TcCO2	transcutaneous carbon dioxide
TCO2, TcO2	transcutaneous oxygen
TCO2	total carbon dioxide
Temp, TEMP	temperature
TFC	thoracic fluid content
TGMY	trigeminy
tHb (c)	total hemoglobin (calculated)
TMP, TP	temperature
TV	tidal volume
TVm	mechanical tidal volume

TVs	spontaneous tidal volume
TV-in	inspired tidal volume
	U
UAC	umbilical artery catheter
UL	Underwriters Laboratories, Inc.
UO	uninary output
UVC	umbilical venous catheter
	V
V	precordial lead
V	volt
VAC	volts AC (alternating current)
VBRADY	ventricular bradycardia
VBRD	ventricular bradycardia
VENT	ventilator
VEPT	volume of electrically participating tissue
V-Fib, V-FIB	ventricular fibrillation
VI	velocity index
VID	video
VNT	ventilator
VT	ventricular tachycardia
VTAC	ventricular tachycardia
V-Tach, V-TACH	ventricular tachycardia
VOL	volume
	W
WOB	work of breathing
WOBm	work of breathing (mechanical)
WT	weight
	X
X	multiplier when used with a number (2X); denotes invalid data when used in place of a value on the display

Symbols

12SL	12-lead ECG analysis
&	and
°	degree(s)
>	greater than
<	less than
–	minus
#	number
%	percent
±	plus or minus
µ	micro

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